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<b>Tiivistelmä – Referat – Abstract</b> <p><b>Introduction.</b> Cognitive abilities are strongly associated with well-being in many aspects of life: more cognition translates to a longer, healthier life with more education and income. Differences in cognitive abilities have been associated with childhood socioeconomic status (SES). This thesis examines, how early-life SES is related to differences in cognitive ability in early adulthood in 473 men born in Helsinki in 1934–1939. In this context SES likely translated into considerable differences in the developmental environments of children, who experienced both the long shadow of the Great Depression and the shock of the Second World War.</p> <p><b>Methods.</b> Linear regression was used to explore the relationship between childhood parental SES and cognitive abilities at the average age of 20.3 years, as measured by the Finnish Defence Forces Basic Ability Test. The problems of over-control bias and collider bias with linear regression were noted. Early-life data came from the Helsinki municipal tax records as well as from birth, child welfare clinic and school records. SES was measured by parental income and father's occupational status. In addition, pre-test education and nutritional status proxied by anthropometrics at 2, 7 and 20 years of age were analyzed as possible mediators, along with some other covariates. Both the models without the mediators and including them were examined, in order to get clues into whether a variable is likely to be a mediator.</p> <p><b>Results.</b> Childhood income was consistently related to adult cognitive abilities in all of the regression models. As expected, the association attenuated when the mediators were added. Father's senior clerical occupational status was also consistently related to the cognitive test scores, while junior clerical status was not statistically significant, when the mediators were included. In comparable standard deviation units, a one SD higher income predicted about 0.26 SD higher cognitive scores without the other variables. When father's occupational status was included, income predicted 0.16 SD higher scores, while father's senior clerical status compared to manual worker status predicted 0.25 SD higher scores and junior clerical status 0.15 SD higher scores. When the other covariates apart from anthropometrics were added, income predicted 0.13 SD and father's senior clerical occupational status 0.17 SD higher scores. Of the mediators, having at least upper secondary education predicted 0.39 SD higher scores. Anthropometrics predicted about 0.06–0.15 SD higher scores for one SD increase in each measure, when individually added to the models.</p> <p><b>Conclusion.</b> This thesis shows that early-life socioeconomic status consistently predicts adult cognitive abilities in a cohort of men born in Helsinki in the 1930s. Education and nutritional status are some possible mediators of this relationship.</p>		
<b>Avainsanat – Nyckelord – Keywords</b> <p>Cognitive abilities, Intelligence, Early-life development, Developmental Origins of Health and Disease (DOHaD), Childhood, Parents, Life-course history, Socioeconomic status (SES), Income, Occupational status, Anthropometrics, Height, Weight, Poverty, The Great Depression, The Second World War, The Helsinki Birth Cohort Study 1934–1944 (HBCS), 1930s, Helsinki, Finland</p>		

# POOR COGNITION

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*Early-life Socioeconomic Status and Cognitive Abilities in  
Adulthood. The Helsinki Birth Cohort Study 1934–1939.*

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## **Abstract**

## **Keywords**

## **List of abbreviations**

<b>1 Introduction</b>	<b>1</b>
1.1 <i>The research question of this thesis and two further questions</i>	2
1.2 <i>Ethics review</i>	3
1.3 <i>Early-life socioeconomic status</i>	3
1.4 <i>Cognitive abilities</i>	6
<b>2 Theory &amp; previous research</b>	<b>8</b>
2.1 <i>The Developmental Origins of Health and Disease (DOHaD) and the early-life developmental environment</i>	8
2.2 <i>Covariates &amp; biological candidate mechanisms</i>	9
2.3 <i>Anthropometrics as indicators of deprivation</i>	12
2.4 <i>Early-life SES, cognitive abilities and anthropometrics: empirical evidence</i>	15
2.5 <i>Social selection or social causation: critical periods, secular trends, education &amp; living standards</i>	17
<b>3 Context: The early-life developmental environment in Helsinki in the 1930s</b>	<b>22</b>
3.1 <i>Birth between the Great Depression and the Second World War</i>	22
3.2 <i>Socioeconomics status, income and household strategies</i>	25
3.3 <i>Social mobility and education</i>	29
3.4 <i>The spatial and linguistic distribution of socioeconomic status</i>	31
3.5 <i>Living conditions</i>	33
3.6 <i>Special circumstances during the war</i>	38
3.7 <i>Anthropometrics during the Great Depression and the Second World War</i>	41
3.8 <i>The accumulation of risk factors</i>	43
<b>4 Data: The Helsinki Birth Cohort Study (HBCS)</b>	<b>45</b>
4.1 <i>The cohort and selection</i>	45
4.2 <i>Previous cognitive studies in the HBCS</i>	51
4.3 <i>Early-life socioeconomic variables</i>	52
4.4 <i>Other socioeconomic variables</i>	57
4.5 <i>Cognitive variables</i>	58
4.6 <i>The mediating variables: Anthropometrics, birth variables, education and evacuation status during the Second World War</i>	60

<b>5 Methods</b>	<b>64</b>
5.1 Problems with bias: over-control bias and collider bias	64
5.2 The structural model	68
5.3 Multiple regression models	70
5.4 Non-linearities and censoring	73
<b>6 Results</b>	<b>74</b>
6.1 Descriptive statistics	74
6.2 Income, father's occupational status and general cognitive ability	78
6.3 Early-life socioeconomic status & visuospatial, arithmetic and verbal abilities	83
6.4 Anthropometrics as mediators	85
6.5 Additional robustness checks	91
<b>7 Discussion &amp; conclusion</b>	<b>93</b>
7.1 Mechanisms of early-life socioeconomic status on cognitive abilities: cognitive stimulation and nutritional status	93
7.2 The developmental environment and human capital	96
7.3 Conclusion	97
<b>8 Bibliography</b>	<b>99</b>
Archive sources	99
Published sources	99
Literature	99
<b>Appendix 1: Recording the tax data, identification of cases and data cleaning</b>	
<b>Appendix 2: Finnish–English tax vocabulary for the 1930s</b>	
<b>Appendix 3: Examples of tax records for 1936 &amp; 1939</b>	
<b>Appendix 4: Conversion of taxable income to real terms</b>	

## ABSTRACT

**Introduction.** Differences in cognitive abilities have been associated with childhood socioeconomic status (SES). This thesis examines, how early-life SES is related to differences in cognitive ability in early adulthood in 473 men born in Helsinki in 1934–1939. In this context SES likely translated into considerable differences in the developmental environments of children, who experienced both the long shadow of the Great Depression and the shock of the Second World War.

**Methods.** Linear regression was used to explore the relationship between childhood parental SES and cognitive abilities at the average age of 20.3 years, as measured by the Finnish Defence Forces Basic Ability Test. The problems of over-control bias and collider bias with linear regression were noted. Early-life data came from the Helsinki municipal tax records as well as from birth, child welfare clinic and school records. SES was measured by parental income and father's occupational status. In addition, pre-test education and nutritional status proxied by anthropometrics at 2, 7 and 20 years of age were analyzed as possible mediators, along with some other covariates. Both the models without the mediators and including them were examined, in order to get clues into whether a variable is likely to be a mediator.

**Results.** Childhood income was consistently related to adult cognitive abilities in all of the regression models. As expected, the association attenuated when the mediators were added. Father's senior clerical occupational status was also consistently related to the cognitive test scores, while junior clerical status was not statistically significant, when the mediators were included. In comparable standard deviation units, a one SD higher income predicted about 0.26 SD higher cognitive scores without the other variables. When father's occupational status was included, income predicted 0.16 SD higher scores, while father's senior clerical status compared to manual worker status predicted 0.25 SD higher scores and junior clerical status 0.15 SD higher scores. When the other covariates apart from anthropometrics were added, income predicted 0.13 SD and father's senior clerical occupational status 0.17 SD higher scores. Of the mediators, having at least upper secondary education predicted 0.39 SD higher scores. Anthropometrics predicted about 0.06–0.15 SD higher scores for one SD increase in each measure, when individually added to the models.

**Conclusion.** This thesis shows that early-life socioeconomic status consistently predicts adult cognitive abilities in a cohort of men born in Helsinki in the 1930s. Education and nutritional status are some possible mediators of this relationship.

## KEYWORDS

Cognitive abilities, Intelligence, Early-life development, Developmental Origins of Health and Disease (DOHaD), Childhood, Parents, Life-course history, Socioeconomic status (SES), Income, Occupational status, Anthropometrics, Height, Weight, Poverty, The Great Depression, The Second World War, Finnish Defence Forces Basic Ability Test, The Helsinki Birth Cohort Study 1934–1944 (HBCS), 1930s, Helsinki, Finland

## LIST OF ABBREVIATIONS

BMI – Body mass index

DAG – Directed acyclic graph

DNA – Deoxyribonucleic acid

DOHaD – Developmental Origins of Health and Disease

FIM – Finnish mark

GDP – Gross domestic product

HBCS – The Helsinki Birth Cohort Study

IQ – Intelligence quotient

NGO – Non-governmental organization

OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares

SD – Standard deviation

SEM – Structural equation modeling

SES – Socioeconomic status

WAIS – Wechsler Adult Intelligence Scale

WHO – World Health Organization

WW2 – World War Two, The Second World War

# 1 INTRODUCTION

The ultimate cause of IQ gains is the Industrial Revolution. The intermediate causes are probably its social consequences, such as more formal schooling, more cognitively demanding jobs, cognitively challenging leisure, a better ratio of adults to children, richer interaction between parent and child.<sup>1</sup>

Flynn has documented the secular trend in cognitive test scores over the 20<sup>th</sup> century. At the same time, the developmental environment changed drastically in most of the world. For example, since the late nineteenth century, the average height of young adult European males increased by about 11 centimeters.<sup>2</sup> Finland is one of the countries where the change in the developmental environment was profound: the country is now one of the richest in the world, while a hundred years ago it was one of the poorest in Europe. A substantial part of this catch-up can be attributed to increased levels of human capital, especially in the second half of the twentieth century.<sup>3</sup> While cognitive abilities are only one aspect of human capital and capabilities<sup>4</sup>, they have important synergies with other capabilities throughout the life-course.<sup>5</sup> Research has clearly established that cognitive abilities are strongly associated with success in many aspects of life: more cognition translates to a longer, healthier life with more education and income.<sup>6</sup>

Socioeconomic status is also strongly associated with cognitive abilities, both in childhood and in adulthood.<sup>7</sup> What causes this association is, however, unclear. There are several proposed candidate mechanisms that are likely to work in conjunction with each other throughout development, such as nutrition, stress, cognitive stimulation, several environmental exposures as well as genetic and epigenetic mechanisms. In addition, poverty can create a cognitive bias by diverting mental capacity to the constant preponderance of financial issues, leaving less room for other cognitive tasks. Poorer adults have been shown to perform worse on cognitive tasks when they are

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<sup>1</sup> Flynn 2012, 15.

<sup>2</sup> Hatton 2014 and Hatton 2010.

<sup>3</sup> Kokkinen 2012.

<sup>4</sup> Capabilities can be defined as alternative combinations of functionings a person has the opportunity to achieve. Functionings are “doings” and “beings”, i.e. various states of human beings and activities that a person can undertake. Sen 1988; Comim et al. 2011, 7.

<sup>5</sup> Heckman 2007.

<sup>6</sup> For a review of the first decade of the 21st century, see Deary 2012.

<sup>7</sup> Hackman et al. 2010; Noble et al. 2007.



induced to think about a stressful financial situation before the task, while the performance of richer individuals is not affected.<sup>8</sup>

This thesis examines the interconnections of socioeconomic status and cognitive abilities in a cohort of men born in the 1930s in Helsinki, Finland. It also adds to the literature examining the mediating factors, especially education and anthropometric measurements as indicators of poor growth and nutritional status in childhood. The thesis shows that cognitive abilities at the average age of 20.3 years are consistently associated with childhood socioeconomic status, measured both by parental taxable income and father's occupational status. Education and nutritional status are tentatively shown to be some of the probable mediators of this relationship.

After this introduction, the next sections present the research questions and key concepts. The second chapter introduces theory and previous research, while the third chapter connects the theory to the context of Helsinki in the 1930s. The fourth chapter introduces the data and discusses selection problems with the study sample. The fifth chapter introduces methodology, including both the preliminary structural model for later structural equation modeling and the empirical strategy in the analyses of this thesis. The sixth chapter presents the results. It first introduces some descriptive statistics of the study sample and compares them to observed differences in the wider Helsinki Birth Cohort. It then presents the linear regression results. The seventh chapter discusses the results and concludes.

### *1.1 The research question of this thesis and two further questions*

This study examines the relationship of childhood socioeconomic status and adult cognitive abilities in a cohort of men born in one of the two public maternity hospitals in Helsinki in the 1930s who also performed the Finnish army conscript cognitive abilities test at approximately the age of 20. The thesis builds a baseline structural model for later structural equation modeling (SEM), incorporating several measures of early-life socioeconomic status as well as several mediating variables. It empirically explores some of the connections of the key variables in this theoretical model with linear regression, while discussing the limitations of that methodology to account for the role of mediation. The thesis focuses on answering the first question below and lays down the framework for how to answer the latter two questions.

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<sup>8</sup> Mani et al. 2013.

1. How is early-life socioeconomic status related to differences in cognitive ability in early adulthood in cohort of men born in Helsinki in the 1930?
2. What is the role of early-life anthropometric variables in mediating this relationship?
3. What is the total effect<sup>9</sup> of socioeconomic status on cognitive abilities when these mediating variables are taken into account?

### *1.2 Ethics review*

The Helsinki Birth Cohort Study has been approved by the Ethics Committee of the National Public Health Institute. Register data have been linked with permissions from Statistics Finland, The Finnish Ministry of Social Affairs and Health and The Finnish Defence Command.

### *1.3 Early-life socioeconomic status*

Socioeconomic status is a multidimensional concept. Income, occupational status, education and wealth are often used as proxies for the concept, but each may have different mechanisms to outcomes like cognitive abilities and growth, alone and in different combinations.<sup>10</sup> For example, financial resources and rank in the social hierarchy may not capture the same dimensions of the concept in isolation from each other. In addition, marital status, family background and neighborhood can also be important determinants of socioeconomic status. The concept of the household is central to the question of early-life socioeconomic status, since children are shaped by the socioeconomic status of their caretakers. While the most immediate references are parents, other household members and the wider social environment can also be important. In Finland, until the 1950s the extended family was still an integral part of the socioeconomic environment of individuals in many instances and the extent of its influence also depended on migration.<sup>11</sup> Thus a focus on nuclear family may introduce considerable measurement error into the measures of socioeconomic status.<sup>12</sup> Unfortunately this disadvantage cannot be avoided in this study.

In Helsinki, average household size had declined between 1920 and 1930. The decline was partly due to fewer children but also due to the dwindling numbers of extended

<sup>9</sup> Total effect constitutes both the direct effect of SES and the indirect effects through the mediating factors.

<sup>10</sup> Cutler et al. 2008.

<sup>11</sup> Parikka 1994b, 53.

<sup>12</sup> On the other hand, the economic contribution from outside the nuclear family was uncertain and not large in magnitude during this period, according to Saaritsa. Saaritsa 2011; Saaritsa 2008.

family living in the same household.<sup>13</sup> In the 1930 census about 30 per cent lived in households of one or two, 18.6 per cent in households of three, 17.3 per cent in households of four, 12.6 per cent in households of five and 12.1 per cent in households of six or seven. For those who have the information in the sample (70 per cent in child welfare clinic records and 63 per cent in school records), the amount of people in the household was in the child welfare clinic records

- three for 56 per cent,
- four for 25 per cent
- and five for 12 per cent of families.

In the school records the figures were

- three for 24 per cent,
- four for 31 per cent,
- five for 24 percent,
- and six for 9 per cent of families.

Wealth was not a particularly important determinant of socioeconomic status for the masses compared to income during this era according to Siipi, since the amount of wealthy habitants was quite low.<sup>14</sup> For most families, father's occupational status was an important determinant of socioeconomic status. Mothers also worked in increasing numbers outside the home, but their earnings were often lower than men's. In 1930, 58.1 per cent of females 15–74 years of age were in the labor force in Helsinki, while the figure was 84.6 per cent for men.<sup>15</sup> Many women also worked part-time or at home as seamstresses or other handicrafts, for which pay was low.<sup>16</sup> Employers were less willing to invest in their training, because they often withdraw from the labor market when married. In many poor families, however, labor supply of the wife was crucial for survival. During the Great Depression, industries dominated by males were the hardest hit and women's labor became central for many families.<sup>17</sup> The same happened again during the Second World War, when many men were at the front. Before the war women formed about 40 per cent of the workforce and during the war as much as half.<sup>18</sup>

According to Siipi the clearest class division was between the middle classes and workers. This was not necessarily based on income but on a perception of occupational

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<sup>13</sup> Siipi 1962, 265.

<sup>14</sup> Ibid., 179.

<sup>15</sup> Helsingin kaupungin tietokeskus 2000, 73, table 4.2: Työelämään osallistuminen sukupuolen mukaan 1900–98.

<sup>16</sup> Siipi 1962, 197.

<sup>17</sup> Suoranta 2001. Similar adaptations were at play, for example, in the United States, as studied by Elder in his 1974 classic study *Children of the Great Depression*. Elder 1999.

<sup>18</sup> Suoranta 2001.

status, although both likely influenced each other.<sup>19</sup> There was also an important divide between skilled and unskilled workers, often referred to as “general workers” or directly translated from Finnish as “mixed workers”<sup>20</sup>. In 1930 more than half of the working age population in Helsinki were manual workers according to a classification by Siipi, based on the census of 1930.<sup>21</sup> A maximum of 42 per cent belonged to the middle classes in 1930, mostly working in commerce, office work or in managerial positions in industry. About 30 per cent of the manual workers worked in industry (35 per cent of men, 18 per cent of women in 1930). In addition, 19 per cent of male workers worked in construction and 41 per cent of female workers in domestic work, most as housemaids. In households headed by women, their occupational status was central to the socioeconomic status of the family, but their socioeconomic status also depended on their marital status: unmarried mothers carried a bigger stigma than widows or single women without children. Marital and occupational statuses interacted: Over a third of the mothers of unmarried children were housemaids in Helsinki in 1934.<sup>22</sup>

According to the 1928 Cost-of-Living Study, income per consumption unit in a worker family was about 54 per cent of that of civil servant families, although the families included in the study represented the more well-off workers rather than all worker families.<sup>23</sup> They all had permanent employment, which was more common in the public sector than in the private sector, where especially unskilled workers suffered from seasonal unemployment. While wages were somewhat lower in the public sector on average, employment was more constant and secure and thus many stayed in the same workplace for a long time.<sup>24</sup> During the study period there was also an expansion of clerical positions and this opened up new employment opportunities for women.<sup>25</sup> Women also formed the majority in secondary schooling already in the early 20<sup>th</sup> century.<sup>26</sup> Parental education was not, however, as important a determinant of socioeconomic status as today, since formal education was still relatively rare after basic education and learning-by-doing at workplaces was important for differences in occupational status, especially inside the working class. In 1950 in the cities of Finland,

<sup>19</sup> Siipi 1962, 184–187.

<sup>20</sup> *Sekatyöläinen* or *sekatyömies* in Finnish.

<sup>21</sup> Siipi 1962, 191–193. Suomen virallinen tilasto 71:I: Väestötilasto, Helsingin väestönlaskenta marraskuun 27 p. 1930, taululiitteitä.

<sup>22</sup> Siipi 1962, 316. The life-course outcomes of the children born to unmarried mothers in this cohort are being examined in another on-going study by Maiju Mikkonen. To date, we know that the children of unmarried mothers in the entire Helsinki birth Cohort 1934–1944 attained significantly lower adult socioeconomic status on average than the children born to married mothers, with respect to education, occupational status and income. Mikkonen et al. 2015 (unpublished).

<sup>23</sup> The different categories were *työläiset*, *toimenhaltijat* and *virkamiehet*. Siipi 1962, 218; Saaritsa 2008; Saaritsa 2011.

<sup>24</sup> Waris 1932, 157.

<sup>25</sup> Siipi 1962, 179. Riihola 2010, 37–39.

<sup>26</sup> Saaritsa & Kaihovaara 2014; Siipi 1962, 197.

64 per cent of the over 15-old population had completed only basic compulsory schooling and 16.9 per cent not even that.<sup>27</sup> In Helsinki, about 12 per cent had completed lower secondary school<sup>28</sup> and about 9 per cent upper secondary school<sup>29, 30</sup>

The empirical part of this thesis focuses on parents' income and father's occupational status as measures of socioeconomic status. These variables are described in more detail in section 4.3. In addition, poor relief recipient and unmarried status have been taken into account, but because of the small absolute number of subjects in each category they have not been included as separate categories in the analyses of this thesis.

#### *1.4 Cognitive abilities*

Cognitive abilities refer to a psychometric property that cognitive tests, such as IQ<sup>31</sup> tests, measure. The concept is considered to be mostly synonymous with intellectual abilities and intelligence. There is some disagreement as to whether there are distinct different dimensions of cognitive abilities or whether most of the concept can be accounted by a common factor, often referred to as general intelligence or the “g factor”. Most researchers agree that variance exists between people on three levels: general cognitive ability, broad domains of cognitive functioning and test-specific variation.<sup>32</sup> According to Deary, general intelligence often accounts for almost half of the variance when different tests are used in the same population, whereas the domain-level variation is relatively small. There is no consensus on the definitions of different relevant domains, but these could contrast, for example, verbal and visual elements of intelligence.

There is also a tendency to divide cognitive abilities into two categories: fluid intelligence that is independent of acquired knowledge and represents logical thinking and problem-solving ability, as well as crystallized intelligence that represents the ability to use skills, knowledge, and experience.<sup>33</sup> This is motivated by the fact that the first type of intelligence seems to show decline during the life-course, while the second type does not. In this thesis cognitive abilities are defined as the qualities measured by

<sup>27</sup> Rahikainen 2011, 379, table 12.

<sup>28</sup> *Keskikoulu*, a more detailed discussion about the school system is provided in section 3.3.

<sup>29</sup> *Lukio*, including the matriculation examination, *ylioppilastutkinto*.

<sup>30</sup> Helsingin kaupungin tietokeskus 2000, 123, table 7.2: 15 vuotta täyttänyt väestö koulusivistyksen mukaan 1930–1970.

<sup>31</sup> Intelligence quotient.

<sup>32</sup> Deary 2012.

<sup>33</sup> *Ibid.*; Flynn 2012, 7.

a test designed by the Finnish Defence Forces to measure visuospatial, arithmetic and verbal skills. The sum of the test scores in the subtests is used as a measure of general cognitive ability. The Defence forces also use the tests as a measure of the “g factor”.<sup>34</sup> The visuospatial test is analogous to one of the most common intelligence tests, Raven’s Progressive Matrices, which is used to measure fluid intelligence.<sup>35</sup> The other two subtests are similar to many international ability tests based on factor models.<sup>36</sup> The tests are described in more detail in section 4.5.

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<sup>34</sup> Nyman 2007, 35.

<sup>35</sup> According to Deary et al. 2010, it is an “established non-verbal test of inductive reasoning that is often regarded as a good marker of the general factor of intelligence”. Nyman 2007, 35.

<sup>36</sup> Nyman 2007, 35.

## 2 THEORY & PREVIOUS RESEARCH

This chapter first introduces the concepts of the Developmental Origins of Health and Disease and the developmental environment. Then it discusses the validity of anthropometric measures as indicators of deprivation and presents some of the empirical evidence available. It concludes by discussing the issue of social causation versus social selection in the context of the heritability of cognitive traits.

### *2.1 The Developmental Origins of Health and Disease (DOHaD) and the early-life developmental environment*

This brief description encapsulates the essence of developmental plasticity: a critical period when a system is plastic and sensitive to the environment, followed by loss of plasticity and a fixed functional capacity.<sup>37</sup>

The hypothesis of this study is based on biological and psychological theory integrated in the paradigm of the Developmental Origins of Health and Disease.<sup>38</sup> This paradigm asserts that the early-life developmental environment affects later-life health through the plasticity of human physiology during rapid phases of development. Related concepts of sensitive periods and critical periods are discussed in more detail later in this chapter. Based on this theory, it is hypothesized that early-life socioeconomic status affects the development of cognitive abilities through the effects of the developmental environment on the brain. The concept of the developmental environment is formulated later in this chapter. This study focuses on the socioeconomic status of the first years of life, because many critical windows of brain development occur during this period, growth is at its fastest and immune function still particularly vulnerable.

Studies of gene expression have modified the old nature versus nurture debate. They have shown that genes and the environment are in constant interaction from way before birth or even conception of an individual, and that genes are more a blueprint to be interpreted by the epigenetic<sup>39</sup> machinery than a strict construction manual for the body and the brain. Neuroscientific and epigenetic research in both humans and animals has identified several mechanisms affecting brain development during critical

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<sup>37</sup> Barker 2007, 415.

<sup>38</sup> Gluckman & Hanson 2006; Barker 2007.

<sup>39</sup> The literal meaning of epigenetic is “over, outside of, around” the genome (epi- from Greek). It refers to phenomena connected to DNA but not only based on the sequence of the nucleotide pairs. The concept will be more clearly defined later in this chapter.

periods leading to changes in gene expression, brain physiology and cognition.<sup>40</sup> Several differences produced by these mechanisms have been shown to vary according to socioeconomic status.<sup>41</sup> Some exposures at specific times during development can lead to irreversible structural changes in the brain while others are reversible, depending on further exposure. Underlying genetic vulnerability may also be triggered by certain environmental exposures at certain times but not others.

In this study the concept of the developmental environment is construed in multiple layers: biological mechanisms transferring environmental exposures to cellular development, the environmental exposures themselves as well as their socioeconomic causes. Some of the hypothesized mechanisms relevant in the context of Helsinki in the 1930s are discussed in more detail in chapter 3. This formulation of the early-life developmental environment integrates biological and psychological stress as different aspects of a suboptimal development. Another way would be to treat stress and investment as separate domains as in the Family Stress Model and the Investment Model.<sup>42</sup> These are the two main theories about the pathways from early-life SES to children's outcomes, including cognitive abilities. The Investment model refers to the effects of financial resources on the physical home environment while the Family Stress Model emphasizes the stressful effects of financial strain on parenting. Since these exposures cannot be directly observed in this study, a joint concept of the developmental environment is used, proxied by anthropometrics. Integrating these two models also highlights more clearly the biological basis of both and their interactions. The concept is operationalized as the structural model presented in 5.2.

## *2.2 Covariates & biological candidate mechanisms*

Several exposures and developmental markers have been associated with cognitive abilities. These include pre-term birth, maternal depression, birth order, birth weight and head circumference, brain size, cortical thickness, brain gray matter volume and white matter integrity, childhood growth, domestic violence, malnutrition, pollution, toxic exposures, parent–child interaction and cognitive stimulation, including education.<sup>43</sup> Many of these associations have been linked to specific patterns of gene

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<sup>40</sup> See Hackman et al. 2010 for a review.

<sup>41</sup> Hackman & Farah 2009; Jednoróg et al. 2012; Hanson et al. 2011; Stevens et al. 2009; Noble et al. 2012.

<sup>42</sup> Cooper & Stewart 2013.

<sup>43</sup> Deary 2012; Deary et al. 2010; Hackman et al. 2010; Bellinger 2012; Koenen et al. 2003; Ferrie et al. 2012; Nilsson 2009; Figlio et al. 2014.



expression, either in humans or in animal studies.<sup>44</sup> They are also correlated with SES to different degrees. There is a possibility that the socioeconomic environment in early-life is not causing differences in exposures, developmental markers and cognitive abilities, but that they are caused by something else correlated with parental SES, such as genetic or epigenetic factors determined already long before conception. This issue will be discussed in section 2.5.

For the biological candidate mechanisms, epigenetics is currently the most important mechanism thought to be responsible for the incorporation of environmental information into gene expression. The field of epigenetics studies changes in gene expression that do not involve mutations to DNA, but act as a dial, turning up and down the expression of various genes.<sup>45</sup> Essentially, the epigenome mediates which genes become active and which stay dormant. While the exact concept of epigenetics is under constant redefinition, in their review Cortessis et al. define *epigenetic processes* as “those that stably affect gene expression through mechanisms not involving the primary nucleotide sequence”, and *epigenetic state* as “the configuration of chromatin and DNA marks utilized by these processes”.<sup>46</sup> Epigenetic marks guide DNA by several different mechanisms that can increase or decrease gene expression and affect subsequent protein production. Later epigenetic effects can reinforce or mitigate the effects of epigenetic effects in early development.<sup>47</sup> Epigenetic processes are currently thought to be especially prevalent in the plastic human brain.<sup>48</sup> The periods of development when epigenetic reprogramming occurs are called *sensitive periods*. One of the most important sensitive periods in humans is in early fetal development when most epigenetic marks are erased and reset to allow for cell differentiation. In sensitive periods the epigenetic marks are susceptible to environmental information. This may come, for example, from the diet, as hormonal signals, such as stress hormones, or from environmental pollutants.<sup>49</sup> Heckman and Conti & Heckman define *sensitive periods* as periods when the effects of investment are especially strong for the development of a capability and those periods as *critical* if an investment is only productive in that one period.<sup>50</sup>

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<sup>44</sup> Hackman et al. 2010.

<sup>45</sup> Gottschling 2007, 2.

<sup>46</sup> Cortessis et al. 2012.

<sup>47</sup> Allis et al. 2007, Damdimopoulou et al. 2012, 44.

<sup>48</sup> Meaney & Ferguson-Smith 2010; Rudenko & Tsai 2013; Schaefer et al. 2009; Suderman et al. 2012; Bagot et al. 2012.

<sup>49</sup> Cortessis et al. 2012.

<sup>50</sup> Heckman 2007; Conti & Heckman 2013.

In animal studies some detrimental brain responses have been removed in adulthood by epigenetic reprogramming in laboratory conditions.<sup>51</sup> In humans, however, the rank order of cognitive abilities measurements seem to be relatively stable over time, at least after about the age of 10.<sup>52</sup> Whereas some aspects of cognitive development can be susceptible to change throughout life, brain development is its most active in infancy and childhood, when growth is the fastest. Harmful environmental exposures or the lack of beneficial exposures may thus create structural limits to later cognitive development in this sensitive period. Heckman has formulated the concepts of *dynamic complementarity* and *self-productivity* to characterize the higher rates of return to investments in human capital during these early years.<sup>53</sup> Falling behind in development even for a short period of time in this vulnerable phase can have long-reaching consequences, because the capabilities acquired at one age enhance the capabilities and the productivity of investments in these capabilities at later ages.

Especially important is the first trimester of pregnancy when epigenetic marks are reset, as well as the first trimester of pregnancy of the grandmother, because this is when the egg that will eventually become the next generation child is created.<sup>54</sup> Accordingly, the pre-conceptional period is also important, because of spermatogenesis. Recently a study in mice showed that the paternal diet before conception can be associated with birth defects, and another study in humans that couples receiving infertility treatment are much more likely to get pregnant if they adhere to dietary recommendations.<sup>55</sup> This could be explained by the absence of methyl-donors that are needed for DNA methylation, an epigenetic mark that is usually associated with gene silencing. Folic acid is one important methyl donor and explains why its absence in the diet can lead to birth defects and low birth weight.<sup>56</sup> This has clear socioeconomic implications because in many countries pre-natal advice is most available to higher socioeconomic groups and key sources of methyl-donors are green leafy vegetables, which are often consumed more by higher socioeconomic groups.

Variations in the DNA methyltransferase genes<sup>57</sup> have also been shown to correlate with childhood intelligence.<sup>58</sup> In addition, animal studies have offered more replicable

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<sup>51</sup> Weaver et al. 2005.

<sup>52</sup> Deary et al. 2010; Heckman 2007.

<sup>53</sup> Heckman 2007.

<sup>54</sup> Hackman et al. 2010.

<sup>55</sup> Lambrot et al. 2013. Twigt et al. 2012.

<sup>56</sup> Bergen et al. 2012.

<sup>57</sup> These are genes that are involved in the epigenetic marking of DNA by methylation, i.e. the incorporation of methyl groups to DNA.

<sup>58</sup> Haggarty et al. 2010.

mechanistic insight and shown that epigenetic effects can be heritable over generations and that the reprogramming phase during the first trimester of pregnancy is especially vulnerable to environmental exposure. Though the findings are mostly concentrated in body size, there is no reason why this should not apply to brain development as well.<sup>59</sup> There is also an emerging role for the gut microbiota and its establishment in early-life for brain development connected to both nutrition and infection, often referred to as the gut-brain axis.<sup>60</sup> In addition, exposure to stress hormones in utero and childhood can also hamper brain development, by affecting neuronal structure, brain connectivity and altering the functioning of physiological feedback systems, such as the hypothalamic-pituitary-adrenal (HPA) axis system, which is vital to cognitive function.<sup>61</sup> Early-life stress has also been connected to differences in measured stress hormone levels in late adulthood, suggesting the possibility of permanent alterations in these systems that have also been witnessed in animal studies.<sup>62</sup>

### *2.3 Anthropometrics as indicators of deprivation*

The physical growth of children quickly declines or ceases with the arrival of adverse socioeconomic conditions, and if bad times persist, stunting registers in adult heights. The growth of children is therefore best for pinpointing the time and duration of short-term adversity but adult heights decline or fall below trend if adverse conditions are particularly severe, continue for a substantial period of time and/or occur during sensitive periods of growth, which are early childhood and adolescence.<sup>63</sup>

Growth is an established indicator of deprivation.<sup>64</sup> Suboptimal growth reflects both poor nutrition and the burden of disease during rapid development. This rapid development occurs mostly in utero, in infancy, early childhood and again in puberty. Thus the lack of resources or other demands competing with the use of available resources during these periods is particularly important. According to Batty et al., plausible non-genetic determinants of height include nutrition, illness, socioeconomic status, and psychosocial stress.<sup>65</sup> Hatton, on the other hand, estimates based on cross-country fixed-effects regressions that the most important proximate source of increasing height in Europe has been the improving disease environment as reflected

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<sup>59</sup> Hackman et al. 2010.

<sup>60</sup> Cryan & Dinan 2012.

<sup>61</sup> Pesonen et al. 2011.

<sup>62</sup> Pesonen et al. 2010.

<sup>63</sup> Steckel 2009, 7.

<sup>64</sup> World Health Organization 1995; Steckel 2009.

<sup>65</sup> Batty et al. 2009.

by the fall in infant mortality. According to him, rising income and education as well as falling family size had more modest effects.<sup>66</sup>

Growth measures reflect the concept of nutritional status, which is a net indicator of biological development. Floud et al. summarize the meaning of nutritional status in their work on the evolution of the human body over the last three centuries:

Nutritional status is a net measure; it represents the energy which has been used for growth once the demands of body maintenance, resistance to disease, play, and work have been satisfied. If nutritional status is inadequate, a child or young person will not grow, either not at all or less than he or she would do under more favorable circumstances. This inadequacy results normally either from lack of food or warmth or the effects of disease – which act in tandem in so much of the developing world even today – but growth can also be affected if the child is expected to undertake significant manual work or even if it is deprived of love and psychological support. Inadequate growth will result in children and adults who are stunted – short compared with some recognized standard – or wasted – light by comparison with some such standard; it can also affect children in less obvious ways, affecting their intelligence or mental capacity.<sup>67</sup>

There is now a consensus that population-level ethnic variations in childhood growth do reflect suboptimal environmental conditions and differences disappear, when these conditions are similar across ethnicities, as established by the WHO Multicentre Growth Reference Study.<sup>68</sup> In addition, the INTERGROWTH-21st Project has concluded that there is no ethnic variation in average normal birth weight and head circumference around the world when measurement methods and environmental conditions are controlled.<sup>69</sup> The same has been proposed for adult height, though it seems to take more than one generation of adequate nutrition for immigrants to change growth patterns.<sup>70</sup> Maternal size and possible epigenetic factors could be mediating this relationship. The World Health Organization published international growth standards for children younger than 5 years in 2006 and for children aged 5 to 19 in 2007.<sup>71</sup> These were recently complemented by standards for fetuses, newborn infants and the postnatal growth period of preterm infants.<sup>72</sup> With these standards it is possible to measure deviations from a growth path considered normal.

The standards are universal and independent of time: they are not intended to be representative of a given population or region at a given time, as opposed to a reference,

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<sup>66</sup> Hatton 2014.

<sup>67</sup> Floud et al. 2011, II.

<sup>68</sup> WHO Multicentre Growth Reference Study Group 2006.

<sup>69</sup> Villar et al. 2014b.

<sup>70</sup> Floud, Fogel, Harris & Hong 2011.

<sup>71</sup> World Health Organization 2006; de Onis et al. 2007.

<sup>72</sup> World Health Organization 2006; Villar et al. 2014a.

and they can be used to assess the size of newborn infants, irrespective of ethnicity, locality, socioeconomic status or healthcare provision.<sup>73</sup>

At birth, the measures most commonly used to reflect net growth in utero are birth weight adjusted for gestational age, birth length, head circumference for gestational age and ponderal index, calculated as (weight in kilograms)/(height in meters)<sup>3</sup>.<sup>74</sup> For infants and children length/height-for-age, weight-for-age, weight-for-length/height and BMI-for-age are used. Body mass index (BMI) is calculated as (weight in kilograms)/(length/height in meters)<sup>2</sup>. Length is used before the age of two years and height after the age of two years. All of these indicators can be used to assess undernutrition. Deficiencies in height growth reflect stunting and are considered to reflect more long-term undernutrition while wasting is considered to affect more acute undernutrition or disease. A standard of two standard deviations below the mean is often used for diagnosis, stunting from length/height-for-age, underweight from weight-for-age and wasting from weight-for-length/height or BMI-for-age. For adults, attained height best represents net growth throughout life, while weight and BMI reflect both cumulative and short term nutritional status.

An infant uses up to 40 per cent of its energy on growth, while this figure falls to approximately two per cent after two years of age.<sup>75</sup> Thus deficiencies in growth during this period are likely to reflect deprivation and have an effect on brain development that is also rapid during this period. As an indicator of nutrition and disease, growth is also an indicator of cognitive stimulation to some extent: without enough energy the child is likely to move less and receive less cognitive stimulation. If there is a reduced intake of energy from food or an increase expenditure of energy in fighting disease, the amount of energy left for cognitive stimulation is likely to be reduced. This is not straightforward, however, because the brain is usually prioritized over other organs and growth in human development. Thus more severe deprivation should translate into a larger effect but it is possible that a slight deprivation may not affect cognitive development that much. Other mechanisms might be more important in these situations. Thus there can also be non-linearities in the relationship between growth and cognitive development.

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<sup>73</sup> Villar et al. 2014a, 866.

<sup>74</sup> The following discussion on anthropometric indicators is based on World Health Organization 1995 and World Health Organization 2006.

<sup>75</sup> World Health Organization 1995.

## *2.4 Early-life SES, cognitive abilities and anthropometrics: empirical evidence*

A systematic review examining the causal impact of money on child outcomes was able to include only 21 studies for cognitive outcomes, mostly from the US.<sup>76</sup> The authors categorized the included studies under four groups of methods: randomized control trials, natural experiments, fixed-effects models and models exploiting exogenous income variation, such as instrumental variable models. 16 of the 21 studies confirmed the causal impact of income. Some of these studies also used some mediating variables, but none used any anthropometric variables. The authors of the review concluded that “poorer children have worse cognitive, social-behavioral and health outcomes in part because they are poorer, and not just because poverty is correlated with other household and parental characteristics.” They also concluded based on five studies that the majority of studies indicate that early childhood matters most for cognitive outcomes. Another important conclusion was that the size of identified effects is highly sensitive to the methods used and that some methods even in this restricted group of causal studies likely underestimated the causal effect of income.<sup>77</sup> Some of the studies also confirmed that there are significantly larger effects in lower-income households for at least some child outcomes. Cooper & Stewart also reviewed the evidence on the Family Stress Model and the Investment Model and concluded that there is more consistent evidence for the mechanisms of the Family Stress model and more limited evidence for the Investment Model, though some studies find significant effects for cognitive development. Some of the studies also suggest that these models interact and should be considered together.

The review included only studies conducted in OECD countries and only looked at income, not other individual or composite measures of SES. The review did not include studies that utilized structural equation modeling (SEM) in the main analysis of causal studies, since a causal impact cannot be confirmed with SEM. It did, however, include studies using SEM for examining the evidence about the mediators of this relationship. Compared to studies using linear regression to draw conclusions about socioeconomic status on cognition, there are relatively few using SEM, which is the preferred method for examining the role of the mediating factors and the total effect of SES. To the best of my knowledge thus far, I am only aware of one study linking cognitive abilities to early-life SES via anthropometric variables as indicators of the developmental

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<sup>76</sup> Cooper & Stewart 2013.

<sup>77</sup> Fixed-effect estimates were consistently lower than those obtained with other methods.

environment.<sup>78</sup> With data from a birth cohort born in the UK in 1970, Silva et al. built a very similar model than the baseline structural model presented in section 5.2, but with the outcome at age 10. Another study from the US with children born in the 1980s has less anthropometric variables but several mediating latent factors that are known to affect the development of cognitive abilities, such as parenting style and cognitive stimulation.<sup>79</sup> It does not, however, use SES as the exposure, but the proportion of years in which the family lived below the official poverty line since the child's birth.

The first study concludes that anthropometric variables matter both as mediators of socioeconomic status and as independent variables but most of the association of socioeconomic status with cognitive abilities is direct. In this study cognitive function increased by 0.56 standard deviation units for each 1 standard deviation unit increase in socioeconomic status, as measured by a latent factor that incorporated information on father's occupational status and education. The direct effect accounted for the majority of this and was 0.48 SD units. The other study on the other hand concludes that its latent factors explain all of the association between poverty and cognitive abilities. The strongest mediator seems to be cognitive stimulation, followed by parenting style and ill health. The direct association in the first study could be explained by the latent factors used in the second study while these factors might also partly include the anthropometric effects, since they include aspects of the physical environment, ill health and parental stress. The greater ability of the second study to account for the pathways between exposure and outcome could also reflect the fact that the study uses poverty as the exposure and not socioeconomic status.

In addition, an unpublished working paper looks at this question in a UK cohort born in the early 2000's, but only includes birth weight as an independent variable and not in the causal pathway from socioeconomic status to cognitive abilities.<sup>80</sup> It concludes that children born into poverty have significantly lower test scores, and that continually living in poverty in early years has a cumulative negative impact on cognitive development. Several other studies also look at childhood cognitive outcomes without anthropometric variables and consistently find important effects of cognitive stimulation and parenting, as expected.<sup>81</sup> Some of them have, however, a limited SES-variable with two studies using just maternal education. One study also uses a

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<sup>78</sup> Silva et al. 2006.

<sup>79</sup> Guo & Harris 2000.

<sup>80</sup> Dickerson & Popli 2012.

<sup>81</sup> Kiernan & Huerta 2008; Gershoff et al. 2007; Tucker-Drob 2013; Mistry et al. 2008; Mistry et al. 2010; Biedinger 2011; Linver et al. 2002; Mistry et al. 2004; Raviv et al. 2004; Yeung et al. 2002.

composite measure of economic deprivation and one a composite measure of family and social risk.

One of these studies looks at cognition both in childhood and young adulthood, but with cross-sectional data.<sup>82</sup> This study finds that most of the association between parents' education and children's different cognitive abilities is accounted for by a single latent pathway, except for academic knowledge and mathematical skills. This is compatible with there being a common cognitive component in the different cognitive abilities measurements, except for the skills directly acquired at school. It could be described as a "g factor" that is transmitted from parents to children. In addition, in this study differences in the cognitive measurements are already present in childhood, but they also widen consistently throughout development. There are also several SEM studies linking early-life socioeconomic status and cognitive abilities in late adulthood.<sup>83</sup> None of these studies use anthropometric variables in the hypothesized causal pathway from early-life SES to the outcome. These studies give contrasting results as to whether childhood SES has independent contributions to cognition or if its effect is completely mediated by later life SES. These results may also reflect differences in the models, SES measures or the study contexts. In addition, investments in cognitive abilities have been shown to be associated with the SES of previous generations and both poor parenting practices and growing up in a poor neighborhood have been suggested to have intergenerational effects.<sup>84</sup>

### *2.5 Social selection or social causation: critical periods, secular trends, education & living standards*

Because of the paucity of causal studies of the relationship between SES and cognitive abilities, it has not been clear whether the association reflects social selection or social causation. Social selection would mean that the early-life developmental environment does not itself cause the differences in cognitive ability but that those predisposed to develop worse cognitively are born into lower socioeconomic groups. This view often stresses the presumed genetic heritability of cognitive traits. Social causation, on the other hand, would mean that the developmental environment itself causes the differences, regardless of the initial selection into different socioeconomic groups. The few causal studies reviewed by Cooper & Stewart suggest that social causation is at

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<sup>82</sup> Tucker-Drob 2013.

<sup>83</sup> Johnson et al. 2010; Singh-Manoux et al. 2005; Horvat et al. 2014.

<sup>84</sup> Sohr-Preston et al. 2013; Sharkey & Elwert 2011; Byford et al. 2012.



least in part at play, as several biological mechanism reviewed in the previous sections would imply. Interventions also show that the cognitive abilities of disadvantaged children can be improved, even if these improvements sometimes fade out after the intervention.<sup>85</sup> This demonstrates the cumulative nature of cognitive development. Longer term effects have been demonstrated, for example, in Norway, where exogenous variation in child care enrollment has shown that on average four months earlier enrollment has a substantial beneficial effect for children's performance on languages and mathematics tests at age seven.<sup>86</sup> These effects are stronger for children of low income parents.

In addition, Van den Berg et al. investigated whether there are specific critical periods<sup>87</sup> in childhood for cognition by comparing brothers born 1956–1979 at different developmental stages migrating from a poorer country to Sweden.<sup>88</sup> Finland was the most common source of immigrants, followed by Iran, Iraq and Bosnia. In a family-fixed effects design with exogenous variation in the developmental environment by migration, older brothers performed worse in adulthood in Swedish military cognitive tests similar to the ones used in this thesis. This effect was seen at all ages, but they also identified a critical period for cognitive development at about the age of 8 or 9. Thus brothers who migrated before this age fared considerably better than those who were older at the time of migration. In addition, the authors also identified a critical period for adult height at about the age of nine.

The sample of the paper was based on Swedish register data that essentially covers the entire population in the country. For cognitive abilities and height, the sample was restricted to families with at least two brothers who were enlisted to the army, which was compulsory in Sweden at the time. This possibly biased the sample towards lower socioeconomic status families, because having two sons in the family is more likely if the number of children is larger and lower socioeconomic status families tend to have more children. While brothers do not share all the same genes, there is necessarily no reason younger brothers should have genes more favorable to cognitive development and height, on average. On the contrary, if anything, those firstborn have been shown to be taller on average and to perform better on cognitive tests.<sup>89</sup> Whether this is due to in utero epigenetic programming or the post-natal environment is not known, but at

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<sup>85</sup> Almond & Currie 2011; Hackman et al. 2010; Cooper & Stewart 2013; Nelson et al. 2007; Neville et al. 2013.

<sup>86</sup> Drange & Havnes 2015.

<sup>87</sup> They used critical periods and sensitive periods as synonyms.

<sup>88</sup> Van den Berg et al. 2014.

<sup>89</sup> Black et al. 2011.

least the results of van den Berg et al. cannot be explained by the birth order: if anything, the difference due to the change in the developmental environment between brothers should be underestimated.

While the heritability of cognitive abilities has been estimated to lie in the range of 30 to 80 per cent, it should not be confused with genetic heritability.<sup>90</sup> This estimate is not based on molecular genetic studies, but on behavioral genetic studies comparing monozygotic and dizygotic twins.<sup>91</sup> The interpretations of the results of these studies rely crucially on the assumption that there are no systematic differences in the shared environments between these two types of twins. If this were the case, the heritability estimates of cognitive abilities could be argued to reflect purely genetic causes transmitted in the DNA sequence from one generation to the next. Over the past decade this possibility has been fundamentally challenged by both the Developmental Origins of Health and Disease paradigm and the field of epigenetics. As a result, some have called for a paradigm shift in behavior genetics – to the era of postgenomics: “Neither the genome nor the epigenome determine the nature of the prenatal environment that will induce changes in both.”<sup>92</sup>

The possibility of environmental epigenetic effects does not rule out the key part played by genes in the heritability of cognitive traits, but it raises the possibility that their contribution may be overestimated. This could be especially true in lower-SES groups, whose socioeconomic situation exhibits more uncertainty and who suffer more from socioeconomic shocks. This would also be consistent with the empirical evidence of gene-environment interaction differing according to socioeconomic status. For example, Turkheimer et al. have estimated the heritability to be 71 per cent in the high socioeconomic group and only 10 per cent in the low group, when SES was split in half.<sup>93</sup> In a replication of their study in another population they concluded: “Results suggest that environmental differences between middle- to upper-class families influence the expression of genetic potential for intelligence.”<sup>94</sup> Some genes may also exert their effect only in conjunction with a specific environmental exposure. For example, the children of women with a gene that keeps blood phenylalanine levels too

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<sup>90</sup> Deary et al. 2010.

<sup>91</sup> Molecular genetics has yet to find a single gene associated with cognitive abilities with replication, apart from the widely replicated finding of the e4 allele of the APOE gene corresponding to lower cognition in old age.

<sup>92</sup> Charney 2012.

<sup>93</sup> Turkheimer et al. 2003.

<sup>94</sup> Harden et al. 2007.

high during pregnancy results in significantly lower cognition but only as a result of consuming phenylalanine and depending on the severity of the mutation.<sup>95</sup>

More evidence pointing to the overestimation of genetic inheritance on cognitive ability is the rising trend of IQ over the years, also called the Flynn effect: even though the conceptualization of IQ ensures that the mean is always 100 points and the standard deviation 15, the actual mean has increased systematically in many parts of the world where the tests have been performed over time.<sup>96</sup> The average gains seems to be about 3–5 IQ points per decade.<sup>97</sup> Some studies have found the increase in scores to be concentrated at the lower end of the distribution and large increases have been seen in developing countries, where policies mitigating the effects of environmental factors are likely to be more recent than in the developed countries. For example, 7-year-old Kenyan children have shown some of the largest gains ever recorded on Raven's Progressive Matrices between 1984 and 1998.<sup>98</sup>

The reasons for the rising trend are not clear: some argue that people just learn to answer the questions better, while some argue that better nutrition and education are responsible for this effect. Flynn himself argues that a more scientific mode of thinking is the most important causal factor since 1950s in developed countries at least. He does not believe nutrition to be a key explanation, but does not rule it out for developing countries. According to empirical evidence, education at least seems to have a causal impact. For example, school reforms in Finland and Norway have shown that cognitive test results improve for the children of low-SES parents, when a separate academic track is removed and a comprehensive secondary school system introduced.<sup>99</sup> In Norway the reform seems account for about one third of the secular increase in the test scores and one additional year of schooling increased IQ by about 3.7 points on average.<sup>100</sup> In Sweden the school reform has been shown to have affected the cognition of both the first generation and the second generation sons, the latter through increased maternal education.<sup>101</sup> An increase in sons' height was also observed.<sup>102</sup> Part of these effects could be due to increases in income, since no effects of paternal education were found, and for fathers the educational increase did not increase earnings, while for mothers it did.

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<sup>95</sup> Widaman & Azen 2003.

<sup>96</sup> Flynn 2012; Deary 2012.

<sup>97</sup> Sundet et al. 2004, 350.

<sup>98</sup> Flynn 2012, 56–57.

<sup>99</sup> Pekkala Kerr et al. 2013; Brinch & Galloway 2012.

<sup>100</sup> Brinch & Galloway 2012.

<sup>101</sup> Meghir et al. 2013; Lundborg et al. 2014.

<sup>102</sup> Lundborg et al. 2014.

Studies reporting a shift in the distribution of cognitive abilities are also supportive of the view that environmental causal factors might be at play. Between two genetically rather homogenous cohorts born in Northern Finland in 1966 and 1985–1986, the total incidence of intellectual disability did not change but there was a considerable shift from severe and moderate towards mild disabilities.<sup>103</sup> There has also been a considerable shift in the cognitive disadvantage of being a twin: in the 1930s, 1940s, 1950s and 1960s, twins had mean IQ scores of about one-third of a standard deviation lower than singletons as 11-year-olds in Scotland, while in the 2000s in the UK and in the Netherlands there was no significant difference.<sup>104</sup> It has been argued that this could be due to improved perinatal care.<sup>105</sup> There is, however, evidence that a twin birth lowers the cognitive test scores of existing children, possibly through less parental attention.<sup>106</sup>

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<sup>103</sup> Heikura et al. 2003.

<sup>104</sup> Deary 2012.

<sup>105</sup> Ibid., 472.

<sup>106</sup> Black et al. 2010.

### 3 CONTEXT: THE EARLY-LIFE DEVELOPMENTAL ENVIRONMENT IN HELSINKI IN THE 1930S

This chapter first introduces the historical context of Helsinki in the 1930s and then discusses more in detail socioeconomic strategies, neighborhoods and living conditions that together form the early-life developmental environment. It then presents some evidence of socioeconomic shocks on anthropometrics during this era and concludes with a list of possible mechanisms affecting cognitive development in this context.

#### *3.1 Birth between the Great Depression and the Second World War*

Early 20<sup>th</sup> century Helsinki did not experience many periods that could be described as normal, but the period of 1934 to 1939 was surrounded by some particularly exceptional events. The Great Depression was still felt in Helsinki in 1934 and in November 1939 Finland entered World War 2, when the Soviet Union attacked the country. In between of these two exceptional periods there was a brief economic boom, when the Finnish GDP grew at an average of 6.6 per cent per year.<sup>107</sup> While rural Finland had started recovering from the depression in 1932, when export of goods improved, cities took longer to feel the effects.<sup>108</sup> Helsinki was slow to recover, because of the importance of construction work for unemployment. The most severe phase of unemployment lasted from 1928 to the spring of 1934.<sup>109</sup> By 1935 the recovery was in full swing but the problem of unemployment persisted until the end of the 1930s, mostly concentrated in the winter months.<sup>110</sup> By the end of the decade, construction had only reached about 80 per cent of the levels of the height of the previous boom in 1928.<sup>111</sup> During the Depression private consumption dropped by 20 per cent and only reached the pre-Depression level in 1936.<sup>112</sup> Peltola has estimated that the income level dropped on average about 40 to 50 per cent in some worker areas in Tampere between 1928 and 1932.<sup>113</sup> This is similar to the sample of households studied by Elder in Oakland in the US, where income dropped approximately 40 per cent between 1929 and 1933.<sup>114</sup>

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<sup>107</sup> Hjerpe 1988, 46.

<sup>108</sup> Hannikainen 2004, 11; Peltola 2008, 46.

<sup>109</sup> Hannikainen 2004, 49.

<sup>110</sup> Siipi 1962, 207; Saukkonen 1962, 419.

<sup>111</sup> Hannikainen 2004, 160.

<sup>112</sup> Hjerpe 1988, 103.

<sup>113</sup> Peltola 2008, 56.

<sup>114</sup> Elder 1999, 275.

While it is very difficult to estimate the exact number of the unemployed, Hannikainen has estimated that at the height of the depression in November 1932 the unemployment rate was 43.50 per cent for male construction workers in Helsinki.<sup>115</sup> This was high both in national and international comparison.<sup>116</sup> Construction was one of the largest industries in Helsinki, employing about 12 per cent of men working in an occupation in the Census of 1930.<sup>117</sup> It was also probably the industry hardest hit by the depression.<sup>118</sup> The official unemployment figures were much lower, since to be registered as officially unemployed one had to also be entitled to poor relief and thus those figures only include the unemployed in the most severe situations.<sup>119</sup> Official status also entitled the unemployed to relief work, which about 30 to 77 per cent of them got, depending on the year and season.<sup>120</sup> The amount of workers accepted for relief work also increased during the depression and it was a significant factor in reducing long-term spells of unemployment. The duration of unemployment spells before assigned relief work did however increase during the depression, because it was difficult to find suitable relief work and the amount of impoverished workers in need of sustenance kept on increasing as the depression went on.<sup>121</sup> The wages paid for relief work were very low, however, and many required other assistance as well.

In addition to relief work, there were also other means of support, such as some unemployment benefits, free meals, food coupons and actual poor relief. In 1933 at its height the number of poor relief recipients was 19 per cent of the population of the city. The amount of people admitted to the municipal poor house and hospital stays paid by the poor relief board also increased.<sup>122</sup> The relief costs expanded considerably during the depression, and thus the municipality reduced the installments of relief given and discontinued some forms of relief all together. Poor relief remained the last resort but even its criteria were made stricter and the sums allocated reduced.<sup>123</sup>

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<sup>115</sup> Hannikainen 2004, 107. Parikka 1994b was the first to estimate the total unemployment rate during the Great Depression, arriving at even higher figures than Hannikainen, but the figures from Hannikainen are used here, because his methodology improved on that used by Parikka. A key difference in their methods is that Hannikainen does not classify those in relief work as unemployed. Peltola 2008 also included those in relief work as unemployed in his study on Tampere, Peltola 2008, 24. Female unemployment has proved much more difficult to estimate, but it was presumably quite high as well, especially since many women had to enter the workforce during the depression when the income of their spouses was often reduced.

<sup>116</sup> Hannikainen 2004, 109.

<sup>117</sup> *Ibid.*, 11.

<sup>118</sup> Parikka 1994a, 214–218.

<sup>119</sup> According to the annual report of the city administration "the truthfulness of the information they gave and their need for help must be verified by a home visit or based on information in the poor relief central register". Kertomus Helsingin kaupungin kunnallishallinnosta 1934, p. 181.

<sup>120</sup> Parikka 1994a, 249; Hannikainen 2004, 13.

<sup>121</sup> Hannikainen 2004, 67–78.

<sup>122</sup> Siipi 1962, 300 & 306.

<sup>123</sup> Halila 1977, 51.

Unemployment was not the only problem, however, since also wages declined and working hours were reduced. This was somewhat countered by a reduction in prices and rents, which declined by about a quarter.<sup>124</sup> All in all, real earnings declined substantially, a unique phenomenon when internationally compared.<sup>125</sup> In addition, the population of Helsinki grew by more than 8 per cent during the depression and there were many people who temporarily migrated to the city to find work that was not to be found.<sup>126</sup>

Although only a small part of children in this study can be said to have been born during the depression, its socioeconomic effects did not stop abruptly: the prolonged unemployment and drop in real earnings during the depression had led to a depletion of savings and assets and the accumulation of debt in many families, especially in the poorest ones.<sup>127</sup> For example, the customers of pawn shops increased considerably in number during the depression, by 56.8 per cent from 1928 to 1935, way above the increase in the population of Helsinki during this time.<sup>128</sup> Contemporary descriptions also implied that some of the poorest were undernourished in the cities.<sup>129</sup> Some anthropometric evidence on this is provided in section 3.7. Illness also became a more common reason for poor relief in Helsinki.<sup>130</sup> While the repayment of some families' poor relief was waived during the depression, others were still indebted to the municipal authorities during the war years. The inability to pay taxes could also accumulate debt to the municipality. Thus the Great Depression cast a shadow also on the latter part of the decade for parts of the population, just to be followed by another crisis.

The periods of war from November 1939 to March 1940 and from June 1941 to September 1944 are distinct additional source of early-life stress during the study period. The special living conditions during the war are described in more detail in section 3.6. While Helsinki was not occupied during the war and there were no ground battles nearby, there were bombings targeting the capital and it was an exceptional time in many ways. During the Winter War Helsinki was bombed 9 times, with about 120 people dead and 260 injured.<sup>131</sup> 55 buildings were destroyed or damaged. This was

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<sup>124</sup> Hannikainen 2004, 36.

<sup>125</sup> Ibid., 162; Siipi 1962, 215–217.

<sup>126</sup> Parikka 1994a, 237. Siipi 1962, 140.

<sup>127</sup> Parikka 1994a; Elder 1999; Peltola 2008.

<sup>128</sup> Calculated from Parikka 1994a, 241.

<sup>129</sup> Peltola 2008, 70.

<sup>130</sup> Parikka 1994a, 255.

<sup>131</sup> Viljanen 1964, 430; Pesonen 1985, 113–115.

very much less than in many other parts of the country and it has been speculated that the Soviet Union wanted to save Helsinki from bombings, because it assumed it would occupy the country soon. Most of the population of Helsinki was also evacuated outside of the city at the beginning of the war and the population temporarily dropped from about 250 000 to 65 000. During the Continuation war there were bomb attempts during 1942 but only one led to 45 people dead. The most serious bombings happened in 1944, when almost 300 died, more than 700 were injured and more than 200 buildings were destroyed. Some families lost their homes in the bombings and the influx of evacuees also put demands on housing density.<sup>132</sup> During the two wars, more than 5 500 inhabitants of Helsinki were killed, either in the city or at the war front.<sup>133</sup>

The effects of the war for the cohort members may have differed by socioeconomic status or the effects on cognitive abilities might be different for cohorts that lived through this difficult time at different ages. Some of the children were also evacuated to foster homes abroad unaccompanied by their parents. They are discussed more in detail in 3.6. For those who stayed, both the actual bombings and the threat of them might have been influential, as well as the disruption of normal economic functioning of the city. Some fathers also died in the war. All in all, since the Winter War was rather brief and for example food was not yet extensively rationed, it can be hypothesized to have had a smaller effect on these cohorts than the subsequent Continuation War from June 1941 to September 1944, although it is difficult to disentangle their effects because of the different ages at entering each war. Some anthropometric evidence of the effects of this shock is presented in 3.7.

### *3.2 Socioeconomics status, income and household strategies*

The living standards during the latter half of the 1930s were rising, but the two shocks surrounding the period had their effects as well. The peak year 1938 Finnish real GDP per capita is comparable to that of India in 2010 and was about 60 per cent of that of the US in 1938.<sup>134</sup> The aggregate figure obviously hides the unequal distribution of this income, both in different parts of the country, as well as inside the capital. Helsinki as the capital experienced both of the extremes of the socioeconomic range from the wealthiest to the poorest urban dwellers, many of whom had arrived from the countryside during the previous decades, when the population of Helsinki had more

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<sup>132</sup> Näre & Kirves 2010, 26.

<sup>133</sup> Viljanen 1964, 459.

<sup>134</sup> The Maddison Project 2013.



than tripled since 1900 to about 250 000.<sup>135</sup> The previous boom, the end of the 1920s, had been an exceptionally active period of growth but also the 1930s witnessed a growth of population, mostly from migration to the capital from other areas of the country. The growth was slower during the depression years but between 1935 and 1940 the population grew by 12–15 per cent, depending on the source of the estimate.<sup>136</sup>

Raimo Parikka has argued that “everybody was poor in the working class, among manual workers” in Helsinki, all the way until the end of the 1940s. According to him, even most of the skilled workers often had to adjust living expenses and for example the quality of food in their consumption. Parikka based his estimation on a study by Vera Hjelt in 1908–1909, where she defined an amount of money that “let live without being hungry, feeling direct bodily deficiency but does not offer much more”.<sup>137</sup> In his review of Hjelt’s study, Saaritsa noted that this amount of money was based on only one family that Hjelt considered representative of this kind of level of consumption.<sup>138</sup> Thus it is not necessarily a good measure of absolute poverty, but only one contemporary assessment of what fulfills a decent standard of subsistence at the time. Parikka uses this amount of money from the first decade of the century to estimate whether the families of unskilled workers reached it in real terms in the 1930s and 1940s. Based on the average real hourly wages of unskilled workers he concludes that a family with two children reached this level only in one year before the end of the 1940s, in 1939, and that bigger families, families headed by women or families with irregular income did not reach the level at all before the war.<sup>139</sup>

This estimation is based on only considering the income of the household head and thus does not take into account additional sources of income, such as earnings by the wife, children above 15 years of age or extended family and strategies such as taking in lodgers. Since the income of the household head was in many cases the biggest income stream and the estimated contribution of other household members only 15–20 per cent, the estimation gives a rough picture of a small margin for the unskilled worker families during this time, especially in families with more than two dependent children.<sup>140</sup> In addition, the estimation is based on constant employment, a rare luxury for many workers, especially during the winter months. Employment was usually most

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<sup>135</sup> Hannikainen 2004, 39. Siipi 1962, 139.

<sup>136</sup> Siipi 1962, 140.

<sup>137</sup> Parikka 1994b, 51–89.

<sup>138</sup> Saaritsa 2010.

<sup>139</sup> The estimates of real hourly wages come from mixed workers employed by the municipality to Helsinki. In general, the wages for the public sector were lower than in the private sector, so this can be considered as a lower-bound average.

<sup>140</sup> Parikka 1994b, 59.

uncertain for those without a clear occupational skill. They also formed the main part of the unemployed during recessions.<sup>141</sup>

Importantly for this study, the economically most squeezed part of the life-course was for many families the period of having small children in the family.<sup>142</sup> This part of the life-course did not allow for as varied income strategies as other parts of the family life-course. For example, the mother could not necessarily work all the time during pregnancy and when her children were small, if no childcare was available.<sup>143</sup> Parikka argues that employment outside the home for a working class wife before the 1960s was limited to families with less than three children and depended on the possibility of getting child care services from the extended family.<sup>144</sup> In addition, children only became a significant potential source of income after school years, which in the cities usually meant the age of 13 or 14 in the inter-war era.<sup>145</sup> Family size had been declining in Helsinki for quite a while, but there were still families that had a large number of children as well.<sup>146</sup> The situation was especially difficult in families that suffered a crisis during this period, such as the death of a parent, disease or unemployment. The position of different children in their family and the timing of their birth also greatly affected their early-life experience: for example, the infancy of a first-born child in the relatively good years between 1936 and 1938 might have been very different than that of a child born to the same family in 1934 during the depression or in 1939 just before the war.

In addition to the supply of labor by different household members, sometimes families had to resort to other survival strategies, such as informal transfers from extended family or neighbors, debt, selling of assets, charities, pawn shops, peddling, begging or municipal poor relief. During the depression, relief work, free meals and food coupons were also forms of aid to families suffering from unemployment. The system of poor relief was considered humiliating, stigmatizing and harsh.<sup>147</sup> The system had, however, expanded considerably during the Great Depression, when the amount of people given poor relief almost quadrupled.<sup>148</sup> Thus resorting to it could have become slightly more normalized by the time this cohort was born. While before the depression only families

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<sup>141</sup> Peltola 2008, 42.

<sup>142</sup> Parikka 1994b, 60–63 & 81; Oppenheimer 1974.

<sup>143</sup> Peltola 2008, 43.

<sup>144</sup> Parikka 1994b, 65.

<sup>145</sup> Rahikainen 1996.

<sup>146</sup> Waris 1932, 127.

<sup>147</sup> Saaritsa 2008, 169. Parikka 1994a, 66.

<sup>148</sup> Parikka 1994a, 254.

with debilitating illness, disability, death of the household head or an exceptionally large number of dependent children were entitled to apply, during the depression also smaller families suffering from unemployment could be assisted. At the end of the depression in 1935, the amount of people receiving relief due to unemployment was more than 30 times the amount in 1928 in Helsinki. In 1934 and 1935 the most common reason for poor relief was illness, followed by unemployment. These two categories included about three fourths of poor relief recipients.<sup>149</sup> Children born outside of marriage, the abandonment of family, size of the family, alcohol abuse and old age were among the remaining reasons. Parikka has estimated that during the depression it was impossible to stay alive with only poor relief, except for those who were institutionalized.<sup>150</sup>

The relief was in principle to be paid back and thus other sources of sustenance competed with the demand for poor relief that was likely to be in many cases the very last resort.<sup>151</sup> Since applying for it often involved hearing in front of the poor relief board, many wanted to avoid the stigma of applying and because of the cumbersomeness and the requirement to pay back, some of the poorest may not have applied at all. Most of the poor relief given during the 1930s was in reality never reclaimed, but the final decision was made for some only after the Second World War, who thus had to live in uncertainty about the issue for more than a decade.<sup>152</sup> Poor relief was the responsibility of the municipality and it was obliged by law to give poor relief to those residents that could not support themselves or their families. Relief was administered as small sums of money or in kind, such as clothing, food or firewood. Most of the relief was temporary.<sup>153</sup> In addition, some recipients were sent to work institutions or nursing homes, either because they were deemed unable to support themselves, or because of misuse of relief money or as a way of reclaiming earlier benefits.<sup>154</sup> Also hospital expenses and medication were often covered. The relief board was also reorganized in 1936–1937 as the Maintenance Board and the power of civil servants in making the decisions increased.<sup>155</sup>

Because of the stigmatization and cumbersomeness associated with poor relief, families likely prioritized other means of consumption smoothing. Saaritsa has studied the

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<sup>149</sup> Calculated from Parikka 1994a, 254.

<sup>150</sup> *Ibid.*, 256.

<sup>151</sup> Peltola 2008, 26; Saaritsa 2008.

<sup>152</sup> Hannikainen 2004, 83–90.

<sup>153</sup> Siipi 1962, 302–303.

<sup>154</sup> Hannikainen 2004, 83.

<sup>155</sup> Siipi, 1962, 302–304; Halila 1977, 53.

extent of informal transfers, savings and loans for consumption smoothing with the 1928 Cost-of-living Study, concluding that gifts and assistance had only a modest impact and were mostly the instrument of the poor, while informal loans from other workers were important for those with a slightly better standing. Savings then became the dominating force towards the upper end of the income distribution.<sup>156</sup> All of the transfers were small in magnitude compared to other means of coping, such as increasing labor market participation by wives or children, taking in tenants or reducing consumption. All in all, the poorest households were the least capable of consumption smoothing. The participants of the Cost-of-living Study did not, however, represent the poorest of the poor very well, because they had regular employment and both parents present in the family. Thus Saaritsa describes them as “a median elite” of workers.<sup>157</sup> It is also important to note that the year 1928 was the peak of the previous boom and thus the situation was different in the 1930s.

### *3.3 Social mobility and education*

Social mobility was rather low in this environment and a change of career was very difficult. An unskilled worker could rarely become skilled if the skill was not acquired early, either by training on the job or formal vocational training. This formal education was very rare, however, since even in the census of 1950, 87.8 per cent of workers with an occupation had no formal vocational training.<sup>158</sup> Thus the importance of training on the job was central and often depended on securing an occupational position when young. Acquiring a skilled position was especially difficult for those children who only completed the minimal amount of schooling and had to provide income for their families immediately after turning 15 years. If they did not have a choice of position then, they were likely to stay in unskilled positions throughout their lives. Some occupations were easier to change into than others: especially the line between mixed workers and construction workers was blurred, because much of the seasonal work for mixed workers was in construction.<sup>159</sup>

At the time, continuing schooling beyond the basic level required financial resources and thus can be seen as an investment by the parents. This decision might also imply a more general parental interest in the cognitive abilities of the child, which might depend on their education, as well as the need for the children to earn an income for

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<sup>156</sup> Saaritsa 2011; Saaritsa 2008.

<sup>157</sup> Saaritsa 2008.

<sup>158</sup> Parikka 1994b, 72.

<sup>159</sup> Waris 1932, 167.

themselves as early as possible. The Finnish school system was tracked and the most important tracking happened at the age of 11.<sup>160</sup> Some went on to the academically oriented track<sup>161</sup> in lower secondary school<sup>162</sup>, while others continued in primary school<sup>163</sup> on less academically oriented continuation classes<sup>164</sup> for two years, until compulsory schooling was completed at the age of 13 or 14.<sup>165</sup> At the end of the 1940s, two years of additional civic school were also provided but they were voluntary until 1958.<sup>166</sup> If the children did not attend this school, they then continued to vocational training or started working. During the period when the men in this sample went to school, there was a shift towards the academic track in the cities: in the 1945–1946 school year 74.7 per cent of children continued in primary school, while in the 1950–1951 school year the figure was 64.3 per cent.<sup>167</sup> The academic track in lower secondary school lasted for five years, after which many continued to upper secondary school for an additional three years. In this sample 49.5 per cent of the men born 1936 went to upper secondary school, while the figure is 59 per cent for the men born in 1939.<sup>168</sup> At the end of upper secondary school the students took a matriculation examination that provided eligibility for tertiary education in universities.<sup>169</sup>

Admission to the academic lower secondary school involved an entrance exam, a teacher assessment and primary school grades.<sup>170</sup> Since it also required an investment by the parents, it was more likely in higher socioeconomic groups. The fees depended on whether the school was public or private, state schools being considerably cheaper.<sup>171</sup> In state-owned Finnish-taught secondary schools in Helsinki, the proportion of children of industrial worker fathers was about a quarter in the school year 1944–1945. For private secondary schools the figure was about 15 per cent and both figures were much lower for schools teaching in Swedish.<sup>172</sup> In 1936, the children aged 11–15 on the academic track were about 5–11 centimeters taller on average than children who continued on the non-academic track.<sup>173</sup> When the tracking was removed in the 1970s, the army test

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<sup>160</sup> Kaihovaara 2011, 45–53.

<sup>161</sup> *Oppikoulu* in Finnish.

<sup>162</sup> *Keskikoulu*.

<sup>163</sup> *Kansakoulu*.

<sup>164</sup> *Jatkoluokat*.

<sup>165</sup> Tuomaala 2011, 104.

<sup>166</sup> Jauhiainen 2011, 117.

<sup>167</sup> Rahikainen 2011, 378, table 11d.

<sup>168</sup> The percentages are considerably higher for birth years 1934 and 1935, but these birth years include fewer subjects than the others, as described in section 6.1.

<sup>169</sup> Pekkarinen et al. 2009.

<sup>170</sup> Ibid., 967.

<sup>171</sup> Kaihovaara 2011, 45–53.

<sup>172</sup> Havu 1964, 201.

<sup>173</sup> Suomen tilastollinen vuosikirja 1943, p. 53, table 28: Koulunuorison keskipituus ja -paino. Based on Tunkelo 1936.

scores improved for those whose parents had less than secondary education or a low income.<sup>174</sup> This implies that the academic track or the lack of it did have a causal effect on the development of cognitive abilities, at least for the lower socioeconomic classes. The reform also increased social mobility.<sup>175</sup>

### *3.4 The spatial and linguistic distribution of socioeconomic status*

A relevant factor for the socioeconomic context of the population of Helsinki was the strong segregation of neighborhoods by socioeconomic status. An important divide between the world of workers and higher socioeconomic groups was the Long Bridge that connected the city's southern, more affluent neighborhoods to the Northern predominantly worker neighborhoods, such as Kallio, Harju and Vallila. The birth of this workers' area was researched by Waris in his seminal two-volume study in the beginning of the 1930s.<sup>176</sup> The area north of the bridge had grown fast from nearly no habitants in 1870 to about 80 000 in 1930, a period when this area industrialized and urbanized.<sup>177</sup> While connected to the wider city, it was naturally isolated from the south by water and from the west by the railway tracks. Thus this large part of the city was segregated as a predominantly lower-SES area and crossing the bridge was considered a symbolically important border between two worlds. The few more affluent habitants in this area lived in their own isolated communities in villas built before the expansion of the worker areas.<sup>178</sup> In general, the further north one went, the more exclusively working class the neighborhoods became and the more of the workers were unskilled mixed workers.<sup>179</sup> Precise figures of the distribution of workers in different areas are lacking for the 1930s, but in 1922 and in 1950 more than 50 per cent of inhabitants were classified as workers in these areas, in some reaching over 70 per cent.<sup>180</sup>

Apart from the areas "on the North side of the Long Bridge", another important cluster of socioeconomically disadvantaged households was located in the southern suburbs

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<sup>174</sup> Pekkala Kerr et al. 2013.

<sup>175</sup> Pekkarinen et al. 2009.

<sup>176</sup> The study by Waris is considered probably the most important study on the socioeconomic conditions of the working class in Helsinki at the end of the 19th century and the beginning of the 20th century. For example, Karisto 1981, 79–84, reviews studies concerning socioeconomic health differences during this era and according to him the second part of Waris's study "has to be considered the most significant charting of the connections between living conditions and health in the inter-war period". While the study focuses mostly on an earlier period than this study, since it was written just before the study period, it involves many useful insights.

<sup>177</sup> Waris 1932, 2 & 100.

<sup>178</sup> Ibid., 156.

<sup>179</sup> Waris 1932, 167–170.

<sup>180</sup> Helsingin kaupungin tilastollinen vuosikirja 1923, 34, table 31: Henkikirjoissa oleva väestö tammikuun ensimmäisenä päivänä vuosina 1885–1922, ryhmitettynä yhteiskunta-aseman, sukupuolen y. m. mukaan, kaupunginosittain; Siipi 1962, 277–279.

around the Western harbor in Punavuori, Ruoholahti and Kamppi. This area had been the periphery of the city during the second half of the 19<sup>th</sup> century and while firmly integrated in the city in the 1930s, it still retained some of its former character as an area of the poor and characterized by illegal activities.<sup>181</sup> Common to these poorer areas was that they had been peripheral at some point and largely unregulated areas where habitation had spread uncontrolled by authorities. In each area the city officials started to pay attention to the development of the areas as the city grew and the peripheral areas were no longer peripheral. Thus, standards of construction and planning of infrastructure only slowly caught up with the pace of expansion of these areas and the result was often dense habitation and crowded housing.<sup>182</sup> While currently gentrified, both the neighborhoods north of the Long Bridge and near the western harbor have carried their notorious working class reputations until the 21<sup>st</sup> century and the bridge was still an important divide at least until the 1950s.<sup>183</sup>

In addition, there were also symbolic borders between different neighborhoods inside these areas: gangs were formed in different neighborhoods that would fight the gangs from the other areas and solidarity was mostly reserved for one's own neighborhood.<sup>184</sup> Helsinki was also a multilingual city, the most common languages being Finnish and Swedish.<sup>185</sup> While a larger part of the elite was historically Swedish-speaking, there were also many Swedish speakers in all other socioeconomic groups. Within unskilled workers Finnish speakers dominated, but in the worker neighborhoods language was not a divisive factor between individuals according to Waris, although there were some language-related riots during the 1930s.<sup>186</sup> In many workers' quarters children grew up playing with speakers of both languages and thus learned to be naturally bilingual, while often not to the standard required for professional command of the language.<sup>187</sup> Sometimes this command of two languages enabled the children to acquire a better occupational position than their monolingual parents had.<sup>188</sup>

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<sup>181</sup> Waris 1932, 14. Siipi 1962, 336–338.

<sup>182</sup> Waris 1932, 174–219.

<sup>183</sup> Saaritsa 2008, 157–158.

<sup>184</sup> *Ibid.*, 158–159. Waris 1932, 145–146.

<sup>185</sup> In the census of 1930, 69.4 were Finnish speakers and 28.5 Swedish speakers and 48 per cent reported speaking both languages. The third most common language was Russian with 0.8 per cent. Siipi 1962, 161–162.

<sup>186</sup> Waris 1932, 149. Siipi 1962, 171–172.

<sup>187</sup> Waris 1932, 143–145.

<sup>188</sup> *Ibid.*, 144.

### 3.5 Living conditions

The people of Helsinki were not pampered. Consumers had to constantly severely struggle for their living conditions, livelihoods, even literally for their bread. And still, after all, they also experienced a strong increase in the standard of living and a general improvement in living conditions, until the war years destroyed some of the achievements.<sup>189</sup>

*The History of the City of Helsinki 1918–1945*

The children of this cohort were born into a very different Helsinki than their parents, most of whom had not been born in the capital at all.<sup>190</sup> At the turn of the century more than a fifth of children died before their first birthday and the figure was even higher in the poorest neighborhoods.<sup>191</sup> By the time this cohort was born, infant mortality had fallen to 5–6 per cent for all infants and to about 10 per cent for babies born to unmarried mothers.<sup>192</sup> It was still very dangerous to be born out of wedlock, but much less so than just a couple of decades ago: at the turn of the century almost 40 per cent babies born to unmarried mothers had died during their first year of life.<sup>193</sup> Apart from rising living standards, a likely reason for the trend was an intensified focus on preventive health care both from the city officials and private philanthropic organizations that had begun to take root. Regulation and regular inspection of food and sanitary conditions expanded considerably in the first decade of the century, also to the areas beyond the Long Bridge.<sup>194</sup> Already before the turn of the century the area had gotten its own municipal district doctors, midwives and nurses, who were particularly important for preventive care because of home visits to poor households.<sup>195</sup>

The fact that the records of the early development of the cohort members have survived is also one sign of these expanding policies: the philanthropic non-governmental organization (NGO) *Maitopisara*<sup>196</sup>, had established the first milk distribution station with child welfare services in 1904, inspired by an international movement.<sup>197</sup> Gradually child welfare clinics<sup>198</sup> had expanded to seven locations by the beginning of the 1930s. The operations of the clinics also included home visits to the

<sup>189</sup> Siipi 1962, 227.

<sup>190</sup> In the Helsinki Birth Cohort, only 23 per cent of mothers of the children were born in Helsinki, in the sample the figure is 21 per cent. In the census of 1930, 34.1 per cent of the population living in Helsinki had been born in the city, but this figure is not comparable to the previous figures because it includes all age groups. Siipi 1962, 150.

<sup>191</sup> Waris 1934, 123–124.

<sup>192</sup> Siipi 1962, 345. The infant mortality rate is calculated for children under one year of age and compared to those born alive during the same period.

<sup>193</sup> Waris 1934, 126–127.

<sup>194</sup> *Ibid.*, 52, 95–96 & 160–161. For example, in 1899 rules about the selling of foodstuffs and inspection had been approved and implementation began.

<sup>195</sup> *Ibid.*, 79–89.

<sup>196</sup> The name *Maitopisara* means “milk drop” in English.

<sup>197</sup> The following discussion on the child welfare clinics is based on Riihola 2010, unless otherwise noted.

<sup>198</sup> *Neuvola* in Finnish and also *neuvonta-asema* at the time, roughly translated as “consultation station”.



families, especially during infancy. According to a figure cited by Maitopisara, in 1931 about 60 per cent of children under two years old had attended its clinics.<sup>199</sup> While there is no certainty about this figure, an even higher number of children may have attended a clinic, because Maitopisara ran only five of the city's seven child welfare clinics at that time and two were run by another NGO, Kenraali Mannerheimin Lastensuojeluliitto. According to Halila about 50 per cent of the small children in the city were customers of Maitopisara's clinics in the beginning of the 1930s.<sup>200</sup> During the 1930s the municipality also opened some of its own clinics and prepared to take over the administration of the other clinics as well. This development was only completed after the war, however. The services of the clinics were free and voluntary, but children of unmarried mothers were required to receive consultation if they wanted to collect assistance. In addition, the introduction of a maternity grant in 1937 for those with low income encouraged mothers to visit the clinics, since the grant was conditional on seeing a health professional.<sup>201</sup> They could also fill the application at the clinics, which most of them did. The infant mortality of child welfare clinic attendees at least at one welfare clinic was less than half the rate in the entire city, 0.3–2 per cent depending on the year in 1935–1938, and the rate for the children of unmarried mothers was also reduced to about 7 per cent.<sup>202</sup> For comparison, the infant mortality rate of Afghanistan was about 7 per cent in 2013, while the rate for Finland was 0.2 per cent, the lowest in the world.<sup>203</sup>

During the first quarter of the century, there had been a considerable shift in the causes of death from communicable disease towards other causes, but communicable diseases still formed about 30 per cent of causes of death during the 1930s. While death from tuberculosis had halved since the 1880s, there were still 1.7 deaths per 1000 people in the city during the period 1931–1940 and the disease was “still the most dangerous and destructive” in the capital.<sup>204</sup> The most important killer of children of the previous decades, gastroenteritis, had been mostly defeated by the 1930s: deaths from it had reduced 40-fold since the 1880s.<sup>205</sup> Inspection of milk and water treatment and sewerage probably had a large effect, but Waris and Siipi both also attribute part of the decline directly to the consultation given by child welfare clinics and other health

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<sup>199</sup> Riihola 2010, 67.

<sup>200</sup> Halila 1977, 187.

<sup>201</sup> The mothers were required to visit either a doctor or a midwife before the birth.

<sup>202</sup> Riihola 2010, 123.

<sup>203</sup> The United Nations Children's Fund 2014.

<sup>204</sup> Siipi 1962, 341. Waris 1934, 139.

<sup>205</sup> Waris 1934, 134.

organizations during this era.<sup>206</sup> There were still outbreaks of other communicable diseases, such as measles, scarlet fever, diphtheria, typhoid fever and influenza, but they rarely killed many people. A new scourge in the 1930s was polio that could lead to death for 10 per cent of those infected.<sup>207</sup> In the empirical sample of this thesis, the most common diagnoses in childhood were: measles ( $n = 300$ ), pertussis ( $n = 203$ ), chicken pox ( $n = 164$ ), mumps ( $n = 121$ ) and scarlet fever ( $n = 51$ ).<sup>208</sup> A large proportion of children also suffered from rickets ( $n = 166$ ), possibly due to vitamin D deficiency, which can be common in Finland due to the wintertime lack of sunlight. Communicable diseases and infant deaths were no longer concentrated in the poorer socioeconomic areas, as they had been before. During the war the infant mortality rate jumped slightly in some of the workers' districts north of the Long Bridge, mostly because more children were born to unmarried mothers in this area.<sup>209</sup>

Children's health was also followed in school: routine school health checks had been performed by the city doctor for every entering class of 7-year-olds in public schools since 1905.<sup>210</sup> During 1905–1906 the nutritional status of each pupil was also assessed and more than a fourth of the children were deemed undernourished and in need of supplementary nutrition by the city doctor. In some of the schools in the poorest neighborhoods the proportion came close to 40 per cent.<sup>211</sup> While nutrition improved in the following decades, there were still deficiencies especially in the diets of the poorer inhabitants and in particular during crisis times like the Great Depression and the Second World War. The margin for consumption smoothing was small in times of shocks, since Hannikainen has estimated that during this period, about half of the consumption of an average working class family went to food and about 20 per cent to housing.<sup>212</sup> A committee evaluating the nutritional situation of the country in 1940 estimated that “for a great part of our population, several hundred thousand persons, maybe one fifth, nutrition is already because of economic reasons clearly inadequate – If milder flaws in the quality of nutrition are also taken into account, the number of

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<sup>206</sup> Waris 1934, 133; Siipi 1962, 342.

<sup>207</sup> Siipi 1962, 343.

<sup>208</sup> It should be noted that the diagnostic criteria are not known and the diagnosing may not have been systematic. At least in the case of pertussis the number of cases in the cohort seem to be related to the city statistics about epidemics.

<sup>209</sup> Siipi 1962, 345.

<sup>210</sup> Waris 1934, 167.

<sup>211</sup> *Ibid.*, 56–57. It should be noted, however, that the children of the higher socioeconomic classes attended private schools, so these figures only reflect the situation for workers' children.

<sup>212</sup> Hannikainen 2004, 200. Siipi 1962, 219.

inadequately nourished persons grows even higher, reaching at least about half of our population during winter and spring”.<sup>213</sup>

The committee also estimated that there were deficiencies in micronutrients in poor families, especially in vitamins A, C and D. “The lack of these elements is caused above all by the shortage of food, by quantitative undernourishment and not so much by a flawed composition of the diet.”<sup>214</sup> There were also large differences in the diets of school children, children of the working class having the worst diets according to a study by the committee.<sup>215</sup> All in all, only about 3 per cent of school children had rich and varied diets that included a serving of vegetables or fruit at least once a day. About 13 per cent had diets that were deficient in calories.<sup>216</sup> The composition of food consumption was also slightly different in worker and civil servant families in the Cost-of-Living Study of 1928: workers spent less on vegetables, fruit and fish and more on grain and coffee. In both types of families, the diet was mostly comprised of grain and milk products.<sup>217</sup> The largest differences in consumption were in housing and leisure expenditure. Taxes only formed less than 10 per cent of the expenditure in both types of families, though slightly more in civil servant families.<sup>218</sup>

While the emphasis on preventive health care had grown in the previous decades, curative care had not followed suit and there was still a considerable deficit in the number of hospital places in the 1930s that disadvantaged the poorest inhabitants who could not necessarily pay for private care.<sup>219</sup> In addition, there were still many environmental hazards present and dense living conditions in working class areas contributed to these. In 1938, 23.5 per cent of people lived in apartments with three or more people per room and in the most densely inhabited areas, especially Kallio and Vallila, the figure was close to 50 per cent.<sup>220</sup> For those who have the information from child welfare clinic or school records in the sample of this thesis, 41 per cent ( $n = 133$ ) of families lived in one-room apartments. In 1930, 5.7 per cent of habitants in Helsinki lived as lodgers in the same room as the lessor, often a family, and 7.8 per cent lived as subtenants in their own room.<sup>221</sup> The worst housing was often proportional to the number of unskilled workers in an area, since these workers had the most fluctuating

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<sup>213</sup> Komiteanmietintö 1940:5.

<sup>214</sup> *Ibid.*, 88.

<sup>215</sup> *Ibid.*, 200.

<sup>216</sup> *Ibid.*, 192.

<sup>217</sup> Siipi 1962, 220.

<sup>218</sup> *Ibid.*, 221.

<sup>219</sup> Waris 1934, 93. Siipi 1962, 351–356. Saaritsa 2014.

<sup>220</sup> Siipi 1962, 260–266.

<sup>221</sup> *Ibid.*, 264.

income and had to thus live in cheap housing and move often. Since every apartment was considered temporary, great care of the facilities was not necessarily taken and relationships to neighbors were also the least stable.<sup>222</sup> There were often additional subtenants living with a family, even in one-room apartments.<sup>223</sup> Children spent much of their childhood playing in the small yards of their houses. According to Waris “life in the yard left permanent effects both to their physical health and moral development.”<sup>224</sup>

Water flowed from the tap to 86 per cent of households in 1930, 70 per cent had water toilets, 34 per cent bathrooms and 22 per cent warm water.<sup>225</sup> Waste sorting had stopped in 1929 and all waste was collected into bins and transported outside the city to landfills.<sup>226</sup> The first waste water treatment plants had been constructed in 1910 and a comprehensive plan for seven new treatment plants covering most of the city had been agreed on in 1928. The execution of this plan began during the 1930s, before halted by the Second World War in 1939. Thus during the study period only part of the city’s waste water was treated and the shores were often contaminated.<sup>227</sup> One of the most severe problems of the previous decades, the high contamination of the shallow inner bay of Töölö near the city center and close to some of the working class neighborhoods, was solved by the end of the 1930s, when nearly all of the wastewater from both factories and housing flowing to the bay was treated.<sup>228</sup> For other parts of the city the problem only worsened.<sup>229</sup>

45 per cent of apartments had central heating in 1930 and the fuel was most often coke.<sup>230</sup> The rest of apartments were still heated with stoves that used wood and scrap paper.<sup>231</sup> 99 per cent already had electric lighting and gas flowed to 67 per cent of apartments.<sup>232</sup> Some of the poorest still had to use wood for cooking as well. While the location of the city on a cape and surrounded by the sea diverted most visible air pollution away from neighborhoods, local fine particles were likely abundant, especially around the industrial areas where many working class families lived. Power plants were built in Sörnäinen near the working class areas and central heating also produced

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<sup>222</sup> Waris 1932, 223.

<sup>223</sup> Ibid., 260.

<sup>224</sup> Ibid., 212.

<sup>225</sup> Siipi 1962, 243; Helsingin kaupungin tietokeskus 2000, 55, table 3.6: Asuntojen varustelutaso 1910–1998.

<sup>226</sup> Nygård 1999, 249.

<sup>227</sup> Siipi 1962, 351.

<sup>228</sup> Laakkonen 2001, 233.

<sup>229</sup> Siipi 1962, 351.

<sup>230</sup> Ibid., 143. Schönach 2008, 52.

<sup>231</sup> Schönach 2008, 52.

<sup>232</sup> Siipi 1962, 143; Helsingin kaupungin tietokeskus 2000, 55, table 3.6 Asuntojen varustelutaso 1910–1998.

visible pollution.<sup>233</sup> Smoke regulation had begun and been active during the first decade of the 20<sup>th</sup> century, but not enforced since then. Only in the 1950s did measurements of air pollution continue in Helsinki, but research on changing vegetation implied that air pollution had increased considerably during the first decades of the century.<sup>234</sup> Sand was also a problem, as was vehicle pollution, though the number of motorized vehicles was still quite low.<sup>235</sup> The airing of apartments was not common, since the little warmth available was considered more important.<sup>236</sup> Thus the rooms were often stuffy, as well as damp and cold.

Vermin were still a common phenomenon and were repelled with strong chemicals that may also have been harmful for children.<sup>237</sup> In addition, intestinal worms were still common in Finland, although precise figures for Helsinki are lacking.<sup>238</sup> In the sample, 11 subjects have a diagnosis at some point, six of them with the year recorded and all of these in the 1940s. In the entire Helsinki Birth Cohort, 4 per cent have a diagnosis at some point. Since the information comes from the school card, diagnosis made outside of school or infections missed are probably not included, since we do not know how systematic diagnosing was. Parasite infections can result in anemia and at the least compete for the available food with the host. In current day Uganda a follow-up of a randomized control trial showed that treating worms in childhood has a large effect on numeracy and literacy scores 7–8 years later, in the order of 0.2 to 0.4 standard deviations.<sup>239</sup> Children from the poorest income quintile had relatively larger gains than others. This could be at least in part due to increased school attendance and learning, as has been witnessed in other contexts.<sup>240</sup>

### *3.6 Special circumstances during the war*

The socioeconomic circumstances of Helsinki were very different during the Second World War. While the Finnish GDP did not drop dramatically, private consumption

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<sup>233</sup> Schönach 2008, 48 & 58.

<sup>234</sup> Kruut 1999. Schönach 2008, 47.

<sup>235</sup> Nygård 1999, 248.

<sup>236</sup> Waris 1932, 248. Waris 1934, 5–8.

<sup>237</sup> Siipi 1962, 351. Oittinen 1999, 156–158.

<sup>238</sup> Naakka-Korhonen 1997, 38–41. The most infected areas of the most common worm, the broad tapeworm (*Iapamato* in Finnish), were in the Eastern Finnish lakelands and the rate of infection estimated as high as two-thirds. The estimated figure for the whole country was about 20 per cent, both in the 1920s and during the Second World War. For the province of Uusimaa where Helsinki was located, the rate was estimated to be just a few percent, however. Since many people moved from other areas to Helsinki, the rate in the city could be much higher than this though.

<sup>239</sup> Croke 2014.

<sup>240</sup> For example, for the Southern United States, Bleakley 2007.

reduced by almost a quarter.<sup>241</sup> When most men served at the front, it was women who formed most of the workforce.<sup>242</sup> For most children, this meant reduced time spent with their parents and emotional uncertainty.<sup>243</sup> Everybody was obliged to work during the war and children also participated themselves in many work tasks, especially during the summer.<sup>244</sup> Vacations were shortened and many were required to use the reduction by helping with the harvest on the countryside.<sup>245</sup> School semesters were shorter than usual and schooling stopped altogether for the duration of the Winter War, autumn 1941 and due to the bombings in the winter of 1944, when many children were also evacuated to the countryside.<sup>246</sup> This concerned the children born 1934–1937 in this study. Teachers also changed often and the shortage of materials hindered school work.<sup>247</sup> The families of the men serving in the war were paid compensation since the start of the war and salaries since 1940.<sup>248</sup> Rents were rationed since 1941 and the use of offices was also rationed from 1943 onwards.<sup>249</sup>

During the war food and other material supplies were heavily rationed. This disadvantaged the cities the most, since growing food for own use was easier in the countryside, while most inhabitants in the cities had to rely on what was available in the shops. Sometimes it was not enough to be entitled to a ration if there was nothing to buy.<sup>250</sup> When compared to the consumption of 1928, the rations of grain products were approximately of similar magnitude, but since grain formed a larger part of the diet, the rations were not considered adequate according to Siipi.<sup>251</sup> The amount of fats on the other hand, was always less than half and sometimes as low as a fifth of the consumption in normal times. The amount of milk was similarly less than half, although pregnant and lactating mothers as well as children received higher rations than others. Meat was a luxury, at best a fifth of the consumption of normal times.

The rationing began in earnest in 1940 and at times also included tubers and fish.<sup>252</sup> Especially difficult was the winter 1941–1942, when Helsinki for example ran out of potatoes altogether for two weeks. Losing weight during this period was common and

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<sup>241</sup> Hjerpe 1988, 46.

<sup>242</sup> Näre 2008, 9–14.

<sup>243</sup> Näre & Kirves 2010, 13.

<sup>244</sup> Viljanen 1964, 446; Saukkonen 1962, 421; Näre & Kirves 2010, 21.

<sup>245</sup> Saukkonen 1962, 421; Näre 2008, 10.

<sup>246</sup> Tepora 2010, 50–54.

<sup>247</sup> *Ibid.*, 51.

<sup>248</sup> Saukkonen 1962, 397 & 422; Halila 1977, 31.

<sup>249</sup> Siipi 1962, 257–258.

<sup>250</sup> Jaatinen 2008, 121.

<sup>251</sup> Siipi 1962, 225.

<sup>252</sup> *Ibid.*, 227; Jaatinen 2008, 116.

there were deficiencies especially in vitamins.<sup>253</sup> Although the harvest of the summer 1942 helped the situation, mild undernutrition was common until the end of the war and worsened in 1944, when the country lost both the eastern fields to the Soviet Union and the imports from Germany. The rationing continued all the way until 1954.<sup>254</sup> Many were, however, able to complement their official rations through the active black market and those who had friends or relatives in the countryside were in a better position than others.<sup>255</sup> The black market prices were high and thus disadvantaged the poorest, who could not afford them. According to Jaatinen, butter was a better currency during the war than the Finnish mark.<sup>256</sup> Fuel was also rationed and there was a shift from imported energy sources to wood, which was also rationed. Gas and electricity were heavily rationed since 1942 and the use of electricity for heating was banned altogether.<sup>257</sup> The change in energy sources may have made the air cleaner in Helsinki during the war.<sup>258</sup> Private motorized vehicles were scarcely used, but those in use ran on more poisonous fuels.<sup>259</sup> Other rationed materials included, for example, fabric and leather. The shortfall was often replaced with paper.<sup>260</sup>

The inadequate living conditions of the period also made children vulnerable to infectious disease.<sup>261</sup> The lack of clothes and soap meant that it was more difficult to take care of hygiene, especially in the winter months when the disease epidemics were the most common. This was combined with the increased amount of vermin that spread from both the men visiting from the front and from evacuees. Medicine and medical personnel were also prioritized for the war front and hospital places were limited.<sup>262</sup> The first antibiotic was introduced just before the war and probably helped prevent several deaths.<sup>263</sup> Epidemics were the most severe during the winter 1944–1945, when the end of the war resulted in unprecedented mobility. For example the pertussis epidemic killed many. There was also a persistent epidemic of diphtheria from 1943 all the way to 1948, although many children were vaccinated during the epidemic.<sup>264</sup> All in

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<sup>253</sup> Laurent 2008, 78; Saukkonen 1962, 420; Viljanen 1964, 445.

<sup>254</sup> Jaatinen 2008, 146.

<sup>255</sup> Näre & Kirves 2010, 23.

<sup>256</sup> Jaatinen 2008, 135.

<sup>257</sup> Saukkonen 1962, 452 & 455.

<sup>258</sup> Laakkonen 2004, 183.

<sup>259</sup> Schönach 2008, 50.

<sup>260</sup> Laurent 2008, 92; Jaatinen 2008, 134–135.

<sup>261</sup> Näre & Kirves 2010, 24.

<sup>262</sup> Ibid., 25.

<sup>263</sup> Laurent 2008, 66.

<sup>264</sup> Ibid., 84–92.

all, during the war infant mortality was higher in Helsinki than it had been at the end of the 1930s and especially the poorer areas showed worse health.<sup>265</sup>

In addition, a sizeable portion of children in Helsinki were evacuated abroad to temporary foster homes in Sweden, Denmark and Norway at some point during the wars. These children form 13.3 per cent of the Helsinki birth Cohort 1934–1944 and 26.4 per cent of the sample of this thesis. Later-life health and socioeconomic outcomes of these children have been shown to have been worse than for those children who were not evacuated.<sup>266</sup> Most children were evacuated during 1942 and 1944. The experience differed according to the age at and duration of the evacuation and the circumstances in the receiving family. Many were better fed than they would have been in Helsinki, but the emotional distress of being separated from their parents was difficult and the care in some receiving families not adequate.<sup>267</sup> The children came more often from socioeconomically disadvantaged families and the most common reasons stated were illness of the child, a large number of children, loss of parents and the father serving at the front. Many of them were underweight or malnourished at the time of evacuation and for many of the ill children the medical care available abroad was crucial.<sup>268</sup> The evacuations were encouraged by the state and in practice all children under 14 year of age who were willing to go, got the chance.<sup>269</sup>

### *3.7 Anthropometrics during the Great Depression and the Second World War*

There is some anthropometric evidence about the effects of the two socioeconomic shocks surrounding the births of the sample subjects. Alho studied the growth of children in five schools in Southern Helsinki 1926–1937. There was an increase in the heights until 1930, a decline during the Depression and the trend continued upward again after 1933.<sup>270</sup> It should be noted, however, that the school children in Southern Helsinki were probably much less disadvantaged than children in the North, and one of the schools was located in the richest area of the city, Kaivopuisto. Some children also received a free meal in school that probably helped buffer some of the effects of the Depression on growth.<sup>271</sup> For Tampere, Peltola has also reported that the proportion of underweight children in one of the working class neighborhood schools increased to

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<sup>265</sup> Siipi 1962, 345.

<sup>266</sup> See, for example, Räikkönen & Pesonen 2011.

<sup>267</sup> Kirves 2010, 91–118.

<sup>268</sup> Laurent 2008, 80.

<sup>269</sup> Kirves 2010, 94 & 98.

<sup>270</sup> Alho 1940.

<sup>271</sup> Sata vuotta Helsingin kouluruokailun historiaa (1910–2010).



about a quarter. Towards the end of the 1930s the figure was less than 15 per cent. The increase happened despite the fact that poor children received a free meal at school and the proportion of children receiving the free meal increased.<sup>272</sup> Effects on growth have also been reported for some other countries.<sup>273</sup>

For the Second World War, Malmivaara has studied the average heights and weights of about 8400 children from three child welfare clinics, one school and some child day care facilities in Helsinki.<sup>274</sup> In contrast to the Helsinki Birth Cohort, she excluded ill children from her study and only used the data as a cross-sectional sample of each age group in each year. Her sample also included some evacuated children from other areas of the country at different points of the war. She concluded that a clear reduction in height growth occurred for both boys and girls, but that the trend was steeper for boys. The reduction was about 1.8 centimeters for boys and 0.9 centimeters for girls altogether, and the greatest reductions happened during the last three years of the war, even though all children started receiving a free school meal in 1943.<sup>275</sup> The difference was the most pronounced in the youngest school ages from seven to twelve. Her results are similar to those from Norway, where the mean height of children between 8 and 14 years old dropped about 1.5 cm during the war, followed by a rapid catch-up.<sup>276</sup> Reductions in children's growth have also been reported for some other countries.<sup>277</sup> For attained adult height, for example the extreme famine conditions of the Dutch Hunger Winter 1944–1945 had lasting effects.<sup>278</sup> In addition, the Dutch famine studies have looked at birth weight and length. They noted that acute maternal nutritional deprivation seems to affect fetal growth only below a certain threshold.<sup>279</sup> These extreme early-life conditions have also been connected to later-life outcomes and to outcomes of subsequent generations.<sup>280</sup> Poorer outcomes for those exposed have been also found for those whose birth weight was not reduced.

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<sup>272</sup> Peltola 2008, 85–90.

<sup>273</sup> For example, Harris 1994 for British schoolboys and Salvatore 2004 for Argentinian recruits born in the Depression years.

<sup>274</sup> Malmivaara 1949, 23.

<sup>275</sup> *Ibid.*, 63; Sata vuotta Helsingin kouluruokailun historiaa (1910–2010).

<sup>276</sup> Brundtland et al. 1980.

<sup>277</sup> Markowitz 1955; Kimura 1984; Ashizawa et al. 1977; Ali et al. 2000; Vlastovsky 1966; Malmivaara 1949, 13–14.

<sup>278</sup> Van Noord et al. 1995; Susser & Stein 1994.

<sup>279</sup> Stein et al. 1995.

<sup>280</sup> Roseboom et al. 2011; Veenendaal et al. 2013; Lumey et al. 1995.

### *3.8 The accumulation of risk factors*

It can be hypothesized that there were differences in both timing-specific exposures during critical development windows as well as cumulative exposures over the life-course in the context of Helsinki in the 1930s. The theoretical structure of this study and earlier empirical evidence propose that these risk factors cumulated in the lower end of the SES distribution. Especially diets of the lower social classes were not always nutritionally adequate. Both the quantity and quality of nutrition are important: energy is needed for both growth and functioning and if it is inadequate, there is less possibility to move around and trigger environmental stimulation. Nutritional quality is important since different nutrients are needed as building blocks for the body and the brain in different quantities. Environmental pollutants such as smoke from heating and cooking and pollution from factories were also present in the poorer neighborhoods, as well as infections and sometimes unclean water. Stress from financial strain, unemployment or simply from low status in the hierarchy and a meager possibility to control life's unexpected problems was more acute and chronic for the lower socioeconomic groups. Time spent with children may have been more limited for poor parents, cognitive stimulation may have been less frequent and educational opportunities depended on financial resources. This is not to imply that all exposures are clear-cut in favor of higher socioeconomic groups but evidence suggests that the cumulative exposures are more likely to have disadvantaged the poor in these respects.

## DIMENSIONS OF THE EARLY-LIFE DEVELOPMENTAL ENVIRONMENT IN HELSINKI IN THE 1930S:

### **Biological mechanisms**

- Production of hormones, especially stress hormones
- Immune system not fully developed, vulnerability to environmental exposures and inflammation
- Stimuli for brain cells to make synaptic connections
- Epigenetic control of gene expression
- Building blocks for the brain from nutrition

### **Environmental exposures**

- Pollution and other toxic exposures
- Infections and illness
- Improper nutrition
- Lack of parental presence and care-giving
- Lack of presence and care-giving from other family members
- Unsafe social environment, crime
- Stress of the parents
- Discomfort from living conditions
- Exposure to cold and dampness
- Lack of cognitive stimulation
- Stability of the social environment

### **Socioeconomic causes**

- Population density
- Waste management
- Water supply
- Presence of factories
- Using wood for cooking and heating
- Food available to buy and its price
- Food habits and variety
- Other material well-being
- Amount of work outside the home
- Amount of work in the household
- Economic and social difficulties of the parents
- Education of parents
- Family's incentives and ability to pay for further schooling
- Neighborhood characteristics & ability to choose neighborhood

## 4 DATA: THE HELSINKI BIRTH COHORT STUDY (HBCS)

This chapter presents the data from the Helsinki Birth Cohort Study 1934–1944. First, it presents the cohort and the sample, and discusses the problem of selection in the cohort and the sample. Second, it reviews the previous findings on cognitive abilities in this cohort. Third, it describes the new early-life socioeconomic variables that have become available for the cohort, discusses their strengths and limitations and how they are used in this thesis. Fourth, it describes the cognitive variables available for the cohort from the Finnish Defence Forces Basic Ability test. Fifth, it describes the anthropometric, maternal and other variables available and how they are used in this thesis.

### *4.1 The cohort and selection*

The Helsinki Birth Cohort includes 13 345 individuals born in either of the two public maternity hospitals in Helsinki as singletons between 1934 and 1944. Of the men born at the Helsinki University Central hospital, 4 630 had birth and child welfare clinic records available and were still residents of Finland in 1971, when a unique personal identification number was allocated to each Finnish citizen. 872 men identified in the early-life records were either dead or did not live in Finland. 3 544 men also had school records available.<sup>281</sup> The cohort has been described in detail elsewhere.<sup>282</sup> This study uses the data from the men who were born 1934 to 1939 at the Helsinki University Central Hospital that had all the aforementioned data available ( $n = 1402$ ) and whose parents tax information was found for at least one year between 1934 and 1939 in the municipal tax records ( $n = 1040$  or 74.1 per cent). Only the men born at this hospital are used, because the cognitive test results have only been previously searched from microfilms for this part of the cohort, and the early-life socioeconomic information is not yet available for the children born at the other hospital. The different points of selection are depicted in figure 1. For the men born 1934–1939 at the Helsinki University Central Hospital, 689 (49 per cent) had served in the Finnish Defence Forces between 1955 and 1966 and had taken a compulsory cognitive abilities test during the first 2 weeks of their military service at an average age of 20.2 years. In the sample for this thesis, the cognitive test data was available for 497 subjects, 47.8 per cent out of the 1040 subjects who had tax information available and 35.5 per cent

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<sup>281</sup> Eriksson et al. 2001.

<sup>282</sup> Barker et al. 2005; Eriksson et al. 2006; Osmond et al. 2007.

out of the 1402 cohort subjects born at the Helsinki University Central Hospital between 1934 and 1939.

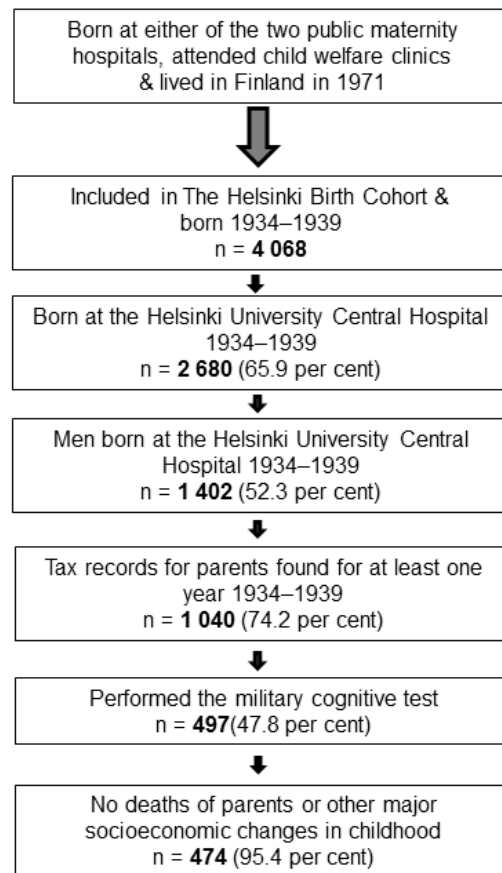


Figure 1: The Helsinki Birth Cohort and the sample.

In addition, 23 subjects were excluded from the analyses due to the fact that the income information from the municipal tax records does not accurately reflect the early-life socioeconomic status of their parents. The reasons were parental death in childhood ( $n = 13$ ), divorce ( $n = 4$ ), other marital status change ( $n = 1$ ), uncertainty about who the child lived with ( $n = 2$ ) and other socioeconomic reason ( $n = 3$ ). The last category included one family whose household head was a student living off debt and two families where only the mother was found in the tax records, but the parents were clearly married in the birth record. The exclusions made based on marital status are described in more detail in section 4.4. In addition, one subject was excluded from the analysis, because the cognitive test results are highly unlikely to accurately reflect his cognitive abilities. He had scored 18/120 points in the test, more than 2 standard deviations below the mean in all subtests compared to the entire cohort, but had parents with senior clerical occupational status and high income. Later in life he

graduated with a university degree and achieved a high official occupational position. It is very unlikely that he could have achieved these in this context if the test is an accurate measure for his cognitive abilities. He was a clear outlier in the analysis of socioeconomic status and cognitive abilities and had a large effect on the standard errors of the regression estimates. Thus he was excluded from the sample. The analyses were also performed with his data included but that did not change any of the conclusions.

Thus the final sample size for the empirical part of this thesis is 473. In addition, three subjects do not have the results for the arithmetic subtest. They are included in the analyses of the other subtests but not in the analyses that uses the sum of the subtest scores as the total score. Additionally, some subjects do not have all the information for each covariate and are thus excluded in some analyses due to missing information. The number of subjects included in each analysis is presented with the results. The tax record data is described in more detail in section 4.3. Some observed differences between the excluded and included subjects are presented in section 6.1.

A limitation of this study is that there is selection at several points. In the previous studies on the same cohort, known differences between participants and non-participants have not been large, but there might be unobserved differences. The first source of selection is that only the children born in public maternity hospitals are included in the cohort. Thus those born either in private hospitals or at home are excluded. The number of children in the Helsinki Birth Cohort and born in the city of Helsinki are presented in table 1 by birth year. The proportion included in the cohort is about a quarter in the later years.

**Table 1. Babies born alive in Helsinki and babies included in the Helsinki Birth Cohort (HBCS)**

Year	Helsinki	HBCS	Percentage in HBCS
1934	2397	369	15.4
1935	2580	457	17.7
1936	2759	711	25.8
1937	3145	682	21.7
1938	3669	839	22.9
1939	4367	1010	23.1

**Source:** Helsingin kaupungin tilastollinen vuosikirja 1937, p. 57 table 58 & 1942/1943, p. 55 table 45.

The second point of selection is the fact that only those individuals who visited child welfare clinics are included in the cohort. As described in section 3.5, attendance was voluntary but free-of-charge and crucially for this study, at least the occupational

distribution of attendees is very similar to that of Helsinki at the time. According to the 1930 census 53.1 per cent of the workforce and 56 per cent of men in Helsinki were manual workers, while the figures for the parents in the Helsinki Birth Cohort are 58.6 per cent for men and 56.7 per cent for women.<sup>283</sup> In the sample of this thesis the figure is 59.1 per cent for the fathers and 55.7 for the mothers. Table 2 presents the distribution of tax units<sup>284</sup> in the sample and in Helsinki in 1938, for which Siipi has made the categorization. The proportion in the sample is slightly lower for the lowest category and higher for the next two categories. The age distribution is, however, likely to be different. The age range for the parents in the sample is 20–50 years for this year.

**Table 2. Tax units of persons in categories in 1938 (%)**

Tax unit	Helsinki	Sample
1–100	41.4	27.8
101–200	24.9	33.3
201–300	18.6	25.4
301–500	8.8	10.3
501–1000	4.2	2.4
1001–	2.1	0.8
n	190 955	126

**Source:** Siipi, Jouko: Pääkaupunkiyhteiskunta ja sen sosiaalipolitiikka, p. 180. In Jutikkala, Eino; Hornborg, Eirik; Waris, Heikki & Castrén, Matti J. (ed.): Helsingin kaupungin historia V:1. Helsingin kaupunki 1962.

There is still no way to know whether the child welfare clinic attendees differed from those who did not attend in some significant aspect. For example, the attending parents could be more interested in their children's health than other parents of the time. The growth of the children was followed at the clinics and the mothers were also advised to follow the growth at home and come to the clinic if the situation deteriorated.<sup>285</sup> As described in section 3.5, the infant mortality rate at one of the clinics was considerably less than in the city in general, either due to selection or the impact of the clinics themselves or both. Thus some of the most disadvantaged children might not be included. This would, if anything, only diminish the ability of this study to find a connection between early-life socioeconomic status and cognitive abilities in adulthood, but if so, the association may be underestimated. It is important to note, however, that the children of unmarried mothers were required to visit health professionals in order

<sup>283</sup> Siipi 1962, 178. Mikkonen et al. 2015 (unpublished).

<sup>284</sup> The tax units are described in more detail in section 4.3. They are roughly equivalent to taxable income divided by 100.

<sup>285</sup> Riihola 2010, 104–107.

to get material support. This way at least many of the children most likely to be the most disadvantaged are included, but for example children living in institutions are excluded. In the sample 18 children (3.8 per cent) were born to unmarried mothers and in the entire cohort this figure is 5.9 per cent for these birth years. In Helsinki at the time about 6–7 per cent of babies were born to unmarried mothers.<sup>286</sup> The upper end of socioeconomic status may also be underrepresented if they did not visit the clinics and used private health care services.

The cohort also excludes individuals living abroad or dead in 1971, when a unique personal identification number was assigned to each citizen of Finland. The study subjects were 32 to 37 years old, so most deaths would have been either due to infant or childhood illness or accidents and other violent deaths. The SES-distribution of the excluded individuals is not known, but could reflect in part highly educated professionals moving abroad and in part the great emigration of the 1960s, when a large part of the Finnish population moved to Sweden for mostly lower-SES work.<sup>287</sup> Some children might also have died in the Second World War, but since there were no ground battles in Helsinki, this would probably concern a small number of children who died in aerial bombings or from diseases and nutritional deficiencies that were more prevalent during the war. Other limitations of the Helsinki Birth Cohort Study have previously been discussed.<sup>288</sup>

The next point of selection in this study is that all women are excluded, so the results will not necessarily apply to women. The sample was further reduced because the parents' tax records were collected only for those who lived inside the borders of the municipality of Helsinki during their first years of life. It is likely that some of these men did not live in the municipality of Helsinki but in the surrounding municipalities, because Helsinki only expanded considerably after 1945. Families with children were more common in the suburbs than in the city proper and thus it is not surprising that some may have only come to Helsinki to give birth or moved away from the city when the children were young.<sup>289</sup> Since the suburbs were closely integrated to the capital, many also worked in Helsinki while living just outside the municipality, especially during the economic booms.<sup>290</sup> There was also a rather large discrepancy between the estimated populations from the state register compared to the church register that

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<sup>286</sup> Siipi 1962, 144.

<sup>287</sup> Hjerpe 1988, 50.

<sup>288</sup> Barker et al. 2005; Osmond et al. 2007; Eriksson et al. 2001.

<sup>289</sup> Siipi 1962, 159.

<sup>290</sup> Hannikainen 2004, 45.



according to Siipi implied that many at least wanted to belong to a parish inside the city even if they lived outside the borders of the city.<sup>291</sup>

Socioeconomically the suburbs around Helsinki were as diverse as Helsinki itself: they included many poorer areas with cheaper housing but the abundance of land and tax competition also drew some wealthier individuals to the suburbs.<sup>292</sup> The municipal border also allowed for a juggling of identities if one wished to disappear from the records of one municipality for any reason.<sup>293</sup> Siipi has also argued that it seems that the surrounding municipalities housed more of those whose residence in the capital area was still uncertain, since the municipalities gained more incomers during good times than the city itself but their population declined during the Great Depression.<sup>294</sup> Taxes were paid to the municipality where the person lived in the beginning of the tax year, and thus the tax records for those moving to Helsinki cannot be observed for the year of moving. Since all the children in the cohort were born in Helsinki, some families may have moved to Helsinki during the birth year. Thus in this thesis also those subjects have been included who have tax records available from some other year than the birth year. This is described in more detail in section 4.3.

Some attrition in the tax records during 1939 is also due to World War 2, because many people moved temporarily to the countryside or were sent to the war front and thus their tax information cannot be collected for those years. When the rest of the family stayed in Helsinki, their income is reported, usually with a mention of the man serving at the front, sometimes with the date of leaving. When these families have at least one year of tax data for both parents, they are included in the study. It should be noted, however, that their income may not be as accurately estimated. Some women also served at the front but since all the families in this cohort had young children, this scenario is not very likely for this population.<sup>295</sup> Some fathers also died at the front and this has been taken into account for those who have this information in the tax records for 1939 or 1940, in the child welfare clinic and school records or in the police address register for those, who were separately verified. Because the tax information is not yet available for all the war years, there might be more cases of parental death.

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<sup>291</sup> Siipi 1962, 142.

<sup>292</sup> According to Parikka 1994a, 234, the households living in Malmi-Tapanila in the north-east of Helsinki were considerably poorer on average than households living in Helsinki in 1930. On the other hand, Siipi mentions that for example the suburbs of Kulosaari, Munkkiniemi, Lauttasaari and Westend drew wealthier individuals. Siipi 1962, 284.

<sup>293</sup> Saaritsa 2008, 149.

<sup>294</sup> Siipi 1962, 152.

<sup>295</sup> Näre 2008, 10.

The final point of selection is that only men who performed the army intellectual abilities test are included. While army conscription was mandatory for all Finnish men, some were freed from duty because of physical or mental handicaps. Probably the most severe cases of intellectual disability are thus excluded from the sample. This should, however, only make it more difficult to find connections to cognitive ability. Some of the possible differences between the study group and the ones who do not have the test results available are examined in section 6.1, but it is impossible to distinguish between those that did not perform the test at all and those whose results are not available for other reasons, such as the destruction of records or mistakes in recording the data from microfilms by researchers. A related point is that systematic testing only began towards the end of the 1950s. Thus a lower proportion of the children born in the earlier years performed the test. The numbers of test takers by birth year are presented in section 6.1. It has been previously reported that the availability of the cognitive test data is not related to childhood socioeconomic status, as measured by father's occupational status in three groups, or to achieved education in adulthood.<sup>296</sup>

#### *4.2 Previous cognitive studies in the HBCS*

In this cohort it has previously been shown that birth weight, head circumference at birth, growth trajectories in infancy and childhood, as well as height at conscription are associated with performance in the military cognitive tests in young adulthood.<sup>297</sup> These results are in line with most other studies.<sup>298</sup> It has also been shown that maternal hypertensive disorders during pregnancy and separation from parents during World War II are associated with lower test scores, longer separation corresponding to a larger effect.<sup>299</sup> In these studies early-life socioeconomic status as measured by father's occupational status has been shown to be strongly associated with test performance. Interestingly, the effects of maternal hypertensive disorders have only been found on subjects of high socioeconomic status. It has been hypothesized that this could be explained by the fact that for the lowest socioeconomic group, father's occupation had by far the strongest impact on the scores and thus the additional effects of pregnancy disorders could have been too small to be detected.<sup>300</sup>

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<sup>296</sup> Kajantie et al. 2010.

<sup>297</sup> Räikkönen et al. 2009; Kajantie et al. 2010.

<sup>298</sup> See, for example, Black et al. 2007; Matte et al. 2001; Silva et al. 2006; Heinonen et al. 2008; Deary 2012; Deary et al. 2010; Figlio et al. 2014.

<sup>299</sup> Tuovinen et al. 2012b; Pesonen et al. 2011.

<sup>300</sup> Tuovinen et al. 2012b.

The test results have also been shown to be strong predictors of later-life socioeconomic outcomes. After adjusting for father's occupational status in three groups, 30–33 per cent of those who scored in the lowest quartiles in the subtests had achieved a high official occupational status in adulthood, while the figures were 79–82 per cent for those scoring in the highest quartile.<sup>301</sup> Similar results were found for education. In addition, the men in the lowest quartile of the test scores in early adulthood have been shown to have twofold higher mortality rates later in life, corresponding to about three excess years of life lost compared with men in the highest quartile. When the sons of manual workers were compared to the highest test score quarter of sons of clerical workers, the loss of lifespan was about three years for those in the highest quartile and about six years for those in the lowest. The gap for the sons of clerical workers was similar for the lowest quarter, six years, but considerably less for the other quarters than for the sons of manual workers.<sup>302</sup>

The observed cognitive differences have also been shown to be highly stable in rank-order for 50 years in the subgroup for whom there is a second test result when they were in their seventies. Some of the anthropometric variables, especially pre-natal growth, have also been associated with cognitive ability at approximately the age of 70 and with cognitive decline.<sup>303</sup> Evacuation abroad during the war has also been associated with the level of cognition, and hypertensive disorders in pregnancy with the level and decline of cognitive function in old age.<sup>304</sup>

### *4.3 Early-life socioeconomic variables*

The following discussion on the socioeconomic variables considers only their use in the empirical part of this thesis. The planned structural equation modeling will include more cases, years and variables, some of which are briefly discussed at the end of this section. Most of the socioeconomic variables come from the Helsinki municipal taxation records and this study is the first one to use this information for the cohort.<sup>305</sup> The information has been gathered by research assistants, including the author, and the verification and cleaning of the data for this thesis was performed by the author in Microsoft Access, IBM SPSS and Stata. Some other socioeconomic variables come from the birth, child welfare clinic and school records and have been previously gathered and

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<sup>301</sup> Pesonen et al. 2013; Räikkönen et al. 2009.

<sup>302</sup> Kajantie et al. 2010.

<sup>303</sup> Räikkönen et al. 2013.

<sup>304</sup> Pesonen et al. 2013; Tuovinen et al. 2012a.

<sup>305</sup> *Kunnanveroluettelo* in Finnish.

re-coded into variables by other researchers involved with the cohort.<sup>306</sup> When the information comes from records other than the municipal tax records, this is noted.

Parental data has been collected from the tax records for each cohort member starting from the birth year and including information from years 1934 to 1939. For some cases, also information from 1940 was used for verification. In this study, for those who have tax information from their birth year, this information was used. For those who have information from some other years, the first available year after the child's birth was used. Most had information available for the birth year. The proportion of birth year used varies from 84.8 per cent for those born in 1935 to 100 per cent for those born in 1939, since this was the last year used. The first year available is also used for mothers, because after examining the data, the differences in mothers' income between either the birth year and the previous year or the subsequent year were not clear-cut and there were both increases and decreases in income. This was also the case for unmarried mothers.

The tax records were based on a population register maintained by the state<sup>307</sup>. The records contain basic information on the taxpayer, such as surname, first and middle names, birth year or birthdate, occupation, address and the amount of underage children. If married, the woman's information was recorded together with her husband's, in the earlier years until 1937 with the letter "v." signifying wife<sup>308</sup> and during the latter years with more detailed marital status entries.<sup>309</sup> In the latter years, also mother's maiden name was included, which assisted identification considerably in uncertain cases, since it was unlikely to be correlated with the father's last name. A description of the procedure of collecting the information and determining correct identification is provided in Appendix 1.

Until the Second World War municipal taxes were actually paid only during the subsequent year: for example, income earned during 1934 was declared to the tax authorities in 1935 and the tax installments only then paid.<sup>310</sup> The records contain the tax units (*veroäyri* in Finnish)<sup>311</sup> used to determine the amount of municipal taxes to be paid by each person, which depended on the price of the tax unit set by the

<sup>306</sup> These records were originally computerized by researchers at the Helsinki City Archives in the 1990s.

<sup>307</sup> *Henkikirja* in Finnish. Saaritsa 2008, 231.

<sup>308</sup> *Vaimo* in Finnish.

<sup>309</sup> These were nm (Finnish) or gm (Swedish) for married man, nn or gk for married woman, n or k for unmarried woman, m for unmarried man, em or fm for divorced man, en or fk for divorced woman, lm or äm for widower and ln or äf for widow.

<sup>310</sup> Parikka 1994a. Information on the tax system is based on Hannikainen 1997; Hannikainen 2004 and Saaritsa 2008, unless otherwise noted.

<sup>311</sup> A short dictionary of the tax terms used in this thesis is provided in Appendix 2.

municipality. A tax unit represents one per cent of the income of the person (in Finnish marks) minus possible tax deductions. Thus multiplying by 100 gives the taxable income.<sup>312</sup> The most important tax deductions were the basic deduction<sup>313</sup> for those with an income under a certain threshold after taxes and the child deduction<sup>314</sup> for each child under 15-years of age in the family. The child deduction was usually granted to the father in families of two earners, because the father was considered responsible as the household head. In addition, there were deductions based on loan interest payments and discretionary deductions based on need. It is not certain in which order the tax deductions were applied. According to Hannikainen, tax authorities had a heated debate in 1934 about the issue and the conclusion seems to be that from 1934 on the basic deduction was made first and only then the child deductions.<sup>315</sup> The tax data and data cleaning are also described in more detail in Appendix 1. Examples of the tax records are provided in Appendix 3.

Because of the tax deductions, the tax units are not direct measures of income and underestimate especially the income of poor families granted the basic deduction and families with a larger number of children granted the child deductions. While it is possible to estimate the income of the household by adding these deductions, as Hannikainen and Saaritsa have done, this is not attempted in this thesis.<sup>316</sup> The main reason is that the number of children is missing for many families in some years and thus would require imputation based on information from the other years to determine the likely amount of children in the missing years. This imputation is better carried out when the tax information from the 1940s is also available. In addition, Saaritsa has noticed that there are discrepancies with the number of children in the tax records and church records for the families he studied from 1928.<sup>317</sup> Since the actual taxation was based on the income declaration form filled out by the taxed individual, the child deductions were likely based on the actual number of children. Thus using the number of children from the tax records would introduce some measurement error in the income estimates. The imputation by using all the available tax years will be able to slightly correct for this, but some uncertainties will remain.

In addition to the measurement error from excluding tax deductions, income from the grey economy cannot be observed and this likely leads to underestimation. Income used

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<sup>312</sup> *Veronalainen tulo* in Finnish.

<sup>313</sup> *Perusvähennys* in Finnish.

<sup>314</sup> *Lapsivähennys* in Finnish.

<sup>315</sup> Hannikainen 1997, 18.

<sup>316</sup> *Ibid.*; Saaritsa 2008.

<sup>317</sup> Saaritsa 2008, 327.

in taxation was also self-reported and thus there was an incentive to misreport. A tax declaration had to be filled out and failure to do so resulted in a sanction of 20 per cent. Since the tax unit of the previous year was marked on the tax records, large changes in income had to be justified. The major local employers were also obliged to report the income of their regular employees, and thus the information for their employees is less likely to be misreported. Since many of the poorest worked in uncertain seasonal occupations, this third source reporting may concern a smaller part of them, however. In addition, according to Saaritsa the surviving income declaration forms and adjoining instructions for a municipality close to Helsinki are rather obscure and difficult to interpret, especially for someone not very well acquainted with the tax system.<sup>318</sup> Saaritsa has also been able to compare the actual income and tax units of a sample of households from the 1928 Cost-of-living Study and concludes that the declared income was likely lower than what should have been declared by law and according to instructions. The closest estimate is the one based on declaring just the main income of the household head.<sup>319</sup> If a wife had no income, the husband made the income declaration for her as well. In addition, income from children under the age of 15 was most often reported as their caregiver's income, if reported at all.

Unfortunately the contributions of other household members apart from the parents cannot be observed in this study. As discussed in section 1.3, the household often included other members than just the nuclear family. These other family members may have earned income themselves or depend on other household members for their living. Thus the measurement error can go both ways. While the household income could be adjusted for the number, ages and sexes of the known household members, this may add further measurement problems and was not attempted in this thesis. All in all, measurement error can be substantial and should thus bias the results towards zero. In the SEM analysis later there might be a possibility to slightly correct for this when taking into account other measures of socioeconomic status simultaneously, but it will not solve most of the problems mentioned above. Since other aspects important to the financial situation of the household cannot be observed, such as debts, wealth and informal transfers, income should also not be directly thought of as the income available for consumption. With all these caveats in mind, the tax units are likely to overestimate poverty. As Saaritsa sums up:

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According to the logic of the tax system, the number of *äyris* ascribed to each person reflected estimated capacity to pay as well as income. Because deductions were granted

<sup>318</sup> Saaritsa 2008, 237–238. Any income declaration forms for Helsinki from this period have not survived.

<sup>319</sup> Ibid., 240–245.

on the basis of having a low income, having many children to support, or experiencing hardship, considering *äyris* as a direct measure of income would exaggerate the income poverty of the poor.<sup>320</sup>

To make the tax units from different years comparable, they have been scaled to real terms with a Cost-of-Living index calculated by Hannikainen.<sup>321</sup> This index deviates slightly from the official index, but improves on it, since the official index only incorporated the information from the 1928 Cost-of-living study from 1937 onwards. Thus the weights in the official index are from a much earlier time period for 1934–1936, while the index by Hannikainen incorporates this information and better represents worker families in Helsinki in the 1930s. For the analysis, the real tax units have been multiplied by 100 to arrive at the income subject to taxation in Finnish marks. In the analyses, the income estimate is expressed as thousands of marks. Contrary to the quite standard practice in econometrics, the logarithm of income is not used, because of the number of those with a zero tax unit ( $n = 33$ ) that would be not included in the transformation. Instead, non-linearities are dealt with by dividing the income estimates into quintiles.

In addition to the income estimate, father's highest achieved occupational status in three groups (manual worker, junior clerical, senior clerical) is used. This information comes from a categorization made previously by other researchers involved with the cohort and includes information from birth records, child welfare clinic records and school records, when available. The grouping of occupations from each of the records was based on the Classification of occupations 1980 by Statistics Finland.<sup>322</sup> When this classification was made for the men born at the Helsinki University Central Hospital, information from the school card was used for 77.3 per cent and information from the child welfare clinic card for 19.8 per cent.<sup>323</sup> A problem with the classification into three groups is that the important differences between unskilled and skilled workers cannot be examined. While not attempted in this thesis, parents' occupational information from the tax records can be used to create a more detailed measure of occupational status than the one used before in this cohort. The tax records include both parents' occupation (if any) in each year of tax collection. Unfortunately it is not known which

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<sup>320</sup> Saaritsa 2008, 233.

<sup>321</sup> Hannikainen 2004, 120–126 & 201. The index is provided in Appendix 4.

<sup>322</sup> Statistics Finland 1981.

<sup>323</sup> Kajantie et al. 2010.

parents had schooling beyond basic education, but those parents with occupation recorded as “student” in the tax records or with an academic degree can be identified.<sup>324</sup>

#### 4.4 Other socioeconomic variables

The records from the 1930s unfortunately do not always contain the detailed marital status variables that became standard during the 1940s, but in this sample the marital status of the parents can be estimated based on whether they were found together or separately in the records and whether they had the same surname, since it was mandatory at this time for the woman to take the man’s name when married. Mother’s marital status from the birth record has been used to determine, whether there are families in the sample for whom only the mother was found in the tax records, even though the parents are marked married in the birth records ( $n = 3$ ). For those families who had the next year’s tax records available 1934–1939 and the parents found together ( $n = 1$ ), this year’s information was used instead of the birth year’s, because it is more likely to reflect the actual socioeconomic situation of the family. Two families were excluded because the parents were only found together in 1940 and that year is not systematically included in this study. In these cases, either the mother was found separately in the birth year tax records, likely because the parents got married that year, or only the father was found since the mother moved to Helsinki during the birth year. In addition, there were some mothers ( $n = 4$ ) who were marked as unmarried in the birth record but found together with a man in the birth year tax record. These have been not included in the analysis as unmarried mothers, because they clearly married the father of the child around the time of birth and lived in the same address. In addition, one mother was marked as widow in the birth record but is treated as married in this thesis, because she was remarried to the father of the child.

In addition to the income estimate, occupational status and marital status, another important variable is poor relief. If the person had received poor relief, a note about this was recorded, usually with the duration and amount of poor relief<sup>325</sup>. A dummy variable has been created for those receiving relief sometime during the 1930s, but the amount received or other details have not been used in this study, since they were not as systematically recorded. In the sample 22 families received poor relief at least once

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<sup>324</sup> It is still not clear whether a separate education variable should be created for them or whether the status of student can be thought of as a relatively high occupational position in this context.

<sup>325</sup> *Köyhäinapu* in Finnish. It was usually recorded as “Köyh. avust.” as in *köyhäinavustus* (fattigund. in Swedish) or “Kh.” as in *köyhäinhoito* or after 1937 as “Hl.” as in *huoltolautakunta*. Sometimes “Kunnan avustus” was also used, meaning municipal relief, which was interpreted as poor relief unless some other specific reason was stated.



1934–1939 according to the tax records. This is 4.64 per cent of the sample, while in Helsinki the figure ranged from 12.1 per cent in 1935 to 6.5 per cent in 1939. These figures are not comparable, however, since the city statistics include individuals of all ages, not just parents with young children.<sup>326</sup>

While not used in the empirical part of this thesis, there are further socioeconomic variables available for the SEM analysis later. Other possible measures used to construct socioeconomic status might be the amount of rooms in the apartment, the amount of family members and the more detailed marital status of the parents. Characteristics of their neighborhood could also be included, with the help of city statistics from that time. Spatial modeling is planned in this cohort, but the results are not available yet.<sup>327</sup> Because of the segregation of neighborhoods in Helsinki, described in section 3.4, the living environment of families and social capital as part of this environment can also form a part of socioeconomic status and can be examined in more detail in the future. In addition, since many of the causal studies have detected non-linearities in the relationships between income and child outcomes, poverty should also be examined in more detail, when the information for the 1940s becomes available. Theory also suggests that the relationship should be stronger for those living in early-life poverty compared to more affluent families. On the other hand, associations of anthropometric variables and cognitive tests have also been found in Finnish children born in the 1980s, when poverty was greatly diminished compared to the 1930s in Finland.<sup>328</sup> Thus the SEM analysis will likely begin by examining the SES in its entirety and then proceed to look more closely at the effects of poverty.

#### *4.5 Cognitive variables*

The cognitive ability measurements come from the Finnish Defense Forces Basic Ability Test that was introduced in 1955.<sup>329</sup> This test was developed at the Finnish Defence Forces Education Development Center to measure general ability and logical thinking and is used in selecting recruits to leadership training.<sup>330</sup> Originally it was based on a similar test in use in Sweden, which was in turn inspired by similar tests used in the US army.<sup>331</sup> Each new recruit completes the test during the first two weeks of their mandatory military service, although testing only became systematic towards the end of

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<sup>326</sup> Siipi 1962, 300.

<sup>327</sup> Jokiniemi 2014.

<sup>328</sup> Heinonen et al. 2008

<sup>329</sup> The discussion on the test is based on Tiitonen et al. 2005, unless otherwise noted.

<sup>330</sup> Nyman 2007.

<sup>331</sup> Ibid., 34.

the 1950s and thus not all of those who underwent their military service in the years before this have completed the test, as described for this sample in section 6.1. The test results have been extensively used for research before and they have shown to be good predictors of different later-life outcomes, such as occupational status, income and mortality. Similar tests in use in Norway have also been cross-validated with the Wechsler Adult Intelligence Scale (WAIS).<sup>332</sup> The correlation between the test results for the people who performed both tests was 0.73.<sup>333</sup> As mentioned in section 4.2, the Finnish test results show high stability over the life-course, as has been witnessed with other tests as well.<sup>334</sup> While taking the possibility of later-life cognitive decline into account, the correlation of test results performed by the same individuals about 50 years apart was 0.87, although this only concerns the subgroup who participated.<sup>335</sup> The group was randomly chosen but attrition may not have been random.

Since performance in the test may also have an effect on the length of service time, some individuals may deliberately underperform in order not to be selected for the leadership training. Whether this was common during the 1950s and 1960s is not known, but it should be noted that the differences in service time were much less during this period: the minimum was 240 days and the maximum 330 days compared to the current day minimum of 165 days and maximum of 347 days.<sup>336</sup> The crucial assumption for this thesis is that the likelihood of underperforming is not systematically related to socioeconomic status. Since there is no evidence of this either way, this caveat should be kept in mind. It should also be noted that while the testing circumstances are similar for all the recruits, for some the intensive period of starting military service may affect test performance more than for others. Whether this is likely to be connected to socioeconomic status is not known. In general, similar selection problems are endemic to all studies using cognitive testing. The advantage of the tests administered to conscripts is that in principle nearly all men in Finland are covered, as discussed in 4.1. Many studies performing the testing in another context often fail to reach parts of the population, especially the lower-end of socioeconomic status that is likely the most important for the mechanisms in this study.

The test is composed of verbal, arithmetic, and visuospatial reasoning subtests, each consisting of 40 timed multiple-choice questions. The verbal and arithmetic subtests

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<sup>332</sup> WAIS is one of the most frequently used intelligence tests. Flynn 2012, 6.

<sup>333</sup> Sundet et al. 2004.

<sup>334</sup> Deary 2012.

<sup>335</sup> Rääkkönen et al. 2013.

<sup>336</sup> Laitinen 2005, 64.

contain four types of questions. In the verbal reasoning test the subject has to choose synonyms or antonyms for a given word, a word belonging to the same category as a given word pair, to identify which word of a word list does not belong in the group, and to identify similar relationships between two word pairs. The arithmetic reasoning subtest consists of tasks of completing series of numbers, solving short problems, computing simple arithmetic operations and choosing similar relationships between 2 pairs of numbers. The visuospatial reasoning subtest consists of a set of patterned matrices with one part removed. It is analogous to the much used Raven's Progressive Matrices. Correct answers in the subtests are summed and this sum is used in this thesis as a measure of general cognitive ability.<sup>337</sup> Because of the effect of age on performance, age of testing is also used as a control variable. The year of testing is not used in the main part of the analysis, because of the high correlation with the age of testing and the short range of different test years that should not reflect a secular trend in test scores.<sup>338</sup>

#### *4.6 The mediating variables: Anthropometrics, birth variables, education and evacuation status during the Second World War*

Early-life anthropometric variables for the cohort have been previously extracted from hospital birth records, child welfare clinic records and school health records.<sup>339</sup> Birth variables available include, for example, weight (g), length (cm), and head circumference (cm). In addition, date of birth, mother's age at delivery, father's age, mother's body mass index (BMI; kg/m<sup>2</sup>), date of last menstrual period (gestational age), hypertensive disorders in pregnancy and parity (primiparous vs. multiparous)<sup>340</sup> are included. The duration of breastfeeding is also recorded. The empirical part of this thesis does not use the birth variables due to reasons described in detail in section 5.1, apart from the information on birth order, which is reflected in a dummy variable that denotes being first-born. Growth measures from infancy and childhood have been estimated monthly from birth to age 2 years and annually up to age 11 years for those whose school records were available, as described elsewhere.<sup>341</sup> Boys born at the Helsinki University Central Hospital had on average 18 measurements of height and weight

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<sup>337</sup> In other studies, also the arithmetic mean has been used, while the Defence Forces convert the scores of each test to standards nine called stanines. It is a method of scaling test scores on a nine-point standard scale with a mean of five and a standard deviation of two. Nyman 2007, 35.

<sup>338</sup> See section 6.5 for a discussion.

<sup>339</sup> The records are described in Forsén et al. 1997 and Eriksson et al. 1999.

<sup>340</sup> Parity means how many times a woman has given birth. In the sample of this thesis the figure is one or two for the most mothers (80 per cent) and the maximum is 9.

<sup>341</sup> Barker et al. 2006; Osmond et al. 2007; Eriksson et al. 2001.

available between birth and age 12.<sup>342</sup> This thesis focuses on the measurements from age two (24 months), because this marks the end of the rapid growth phase. This is also a time point when most of the children have actual measurements that have not been imputed. In addition, height at age seven years is reported for the group who has school records available. This is the first age after 2 years that the majority has measurements, because the child welfare clinic visits were the most frequent until two years of age.<sup>343</sup> It also roughly corresponds to the critical period for cognitive abilities estimated by van den Berg et al.<sup>344</sup> In addition, height, weight and BMI were measured again at conscription. The height of the subjects is used in the empirical analysis.

Unfortunately there is no information on maternal smoking during pregnancy and no statistics of the 1930s and 1940s are available for Finland, but there is a consensus that smoking among women became more frequent only after the Second World War, in contrast to many other Western countries where this happened already after the First World War.<sup>345</sup> Contemporary descriptions and the fact that lung cancer rates for women only picked up from the end of the 1960s onwards give indirect support to this conclusion.<sup>346</sup> A poll conducted at the beginning of the 1960s implied that about 13 per cent of women and 60 per cent of men smoked.<sup>347</sup> Thus smoking during pregnancy should not be a key explanation for a socioeconomic gradient in cognitive abilities for children born in the 1930s. On the other hand, paternal smoking and small particle pollution from burning fossil fuels might plausibly be among the environmental exposures prevalent in this context.

In addition, a separate analysis uses the information of highest education achieved. This information has been previously retrieved from Finnish census data gathered at five year intervals until year 2000 after the introduction of the unique personal identification number in 1971. Unfortunately the entire educational history of each subject is not explicitly recorded but the records contain their highest achieved education as in “unknown”, “pre-primary”, “primary”, “lower secondary”, “upper secondary”, “lowest level tertiary”, “lower-degree level tertiary”, “higher-degree level tertiary” and “doctorate or equivalent level tertiary”. Unfortunately the category for most of this sample ( $n = 193$ ) is “unknown” and the lowest level actually in the data is

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<sup>342</sup> Eriksson et al. 2001.

<sup>343</sup> Osmond et al. 2007.

<sup>344</sup> Van den Berg et al. 2014.

<sup>345</sup> This discussion on smoking is based on Lenkkeri et al. 2013, unless otherwise noted.

<sup>346</sup> Cancer Society of Finland 2009.

<sup>347</sup> Contemporary descriptions from the 1940s also indicate that smoking was considered to be very rare among working class women, while women of higher socioeconomic status may have already picked up the habit because of the example of glamorous film stars.

“upper secondary” ( $n = 92$ ). In addition, there are 177 with tertiary education ( $n = 62$  for lowest level,  $n = 53$  for lower level,  $n = 53$  for higher level and  $n = 9$  for doctorate). This is problematic, since the tracking of the school system after age 11, as discussed in section 3.3, was likely important for the further development of cognitive abilities.

While all of the individuals with upper secondary or tertiary education would have also completed the academic lower secondary school, whether some of the other individuals did is not known. It is likely that they have not completed upper secondary school, because in Finland graduation involves a matriculation examination and a record of this should be included in census data.<sup>348</sup> This is not certain, however, and should be kept in mind when interpreting the results. In 2001, a random sample of the cohort was invited to a clinical study and asked about their years of full-time studying. This information is available for 47.9 per cent of the 689 who have the cognitive test data available for these birth years. Those in the “unknown” category answered ( $n = 123$ ):

- 8 per cent less than 8 years
- 44 per cent 8 years
- 21 per cent 9 years
- 15 per cent 10 years
- and 9 per cent 12 years or more.

8 years corresponds to the law on basic schooling and since completing upper secondary school would require at least 12 years of full-time study, it is unlikely that many of them have completed upper secondary school. In addition, those who have only studied for 8 years are unlikely to have attended the academic track in lower secondary school, since completing middle school<sup>349</sup> on the academic track would have required at least 9 years of full-time studying. The years of studying may also include vocational training. It should also be noted that this information is recalled after the age of 60 and the answers may also depend on how the subject interpreted the question. With these caveats in mind, a dummy-variable reflecting known education beyond basic schooling has been created with 0 for all of those who have an entry “unknown” and 1 for those who have any of the secondary or tertiary categories presented above. In addition, there are 12 individuals with information missing. They are excluded from the analyses using the education variable.

Finally, the information whether the child was evacuated abroad to Sweden or Denmark unaccompanied by parents during World War II is used in this thesis ( $n =$

<sup>348</sup> The census records contain upper secondary education based on having taken the matriculation examination. Helsingin kaupungin tietokeskus 2000, 123, table 7.2: 15 vuotta täyttänyt väestö koulusivistyksen mukaan 1930–1970.

<sup>349</sup> *Keskikoulu*.

125). This information has been previously extracted from records in the Finnish National Archives, as described elsewhere.<sup>350</sup> The individuals participating in the clinical part of the study in old age were also asked about separation experiences. When they reported having been separated from their parents during the war, but not evacuated according to the archive information, they were set as missing ( $n = 17$  in the sample). This is because they may have been evacuated domestically or through private channels abroad, which was not recorded in the archives. The evacuated came more frequently from the lower socioeconomic groups and thus the experience of evacuation can also be partly thought of as a mediator of early-life socioeconomic status. It should also be noted that evacuation status is connected to birth-order, since first-borns were less likely to be among the evacuated, as previously reported for the entire cohort.<sup>351</sup> In the sample, 49.6 per cent of the evacuated are firstborns, while the figure is 57.2 per cent for those not evacuated.

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<sup>350</sup> Pesonen & Räikkönen 2011.

<sup>351</sup> Pesonen et al. 2010.

## 5 METHODS

This chapter first presents problems of bias associated with the question of mediating variables and then briefly describes the method of structural equation modeling (SEM) and the baseline structural model for later implementation. Based on the structural model, section 5.3 presents a simplified model estimated with Ordinary Least Squares (OLS) regression, while taking the biases mentioned in the first section into account. The last section briefly discusses non-linearities and the problem of censoring in the dependent variable.

### 5.1 Problems with bias: over-control bias and collider bias

When examining the total effect of SES on cognitive abilities, it is important to realize that many of the other covariates of cognitive abilities, such as birth weight and height, are also correlated with SES and might lie on a causal pathway from SES to cognitive abilities. Thus controlling for them in linear regression leads to over-control bias and underestimates the effect of SES.<sup>352</sup> With SEM it is possible to integrate these covariates in the same model and test the hypothesized mediating paths. Over-control bias refers to a situation where a variable laying on a causal pathway from exposure to outcome is controlled for. In these situations the total effect of the exposure on outcome cannot be estimated, since part of the effect goes through the indirect effect of the mediating variable. As an example, figure 2 presents the situation with birth weight as a mediating variable.<sup>353</sup> This figure is an example of a Directed acyclic graph (DAG): a visual representation of causal assumptions.<sup>354</sup>

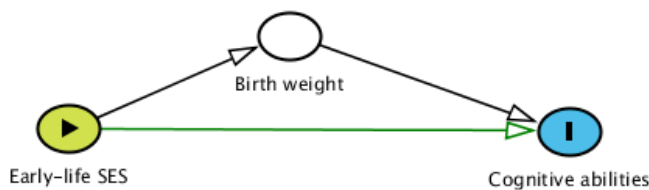


Figure 2: Over-control bias.

<sup>352</sup> Elwert 2013. Controlling, conditioning and adjusting for something are considered synonymous, meaning holding something constant.

<sup>353</sup> The figures in this chapter have been created using the DAGitty.net website. For more information about DAGitty, see Textor et al. 2011.

<sup>354</sup> Elwert 2013.

In this figure, white and black colors denote conditioning. Thus conditioning on birthweight in this situation means that one path between early-life SES and cognitive abilities is essentially removed. In linear regression, conditioning on birth weight would mean comparing the cognitive abilities of those individuals with the same birth weight but different SES. This would be appropriate if estimating how much the effect of either would be independent of the other, i.e. how much birth weight adds to explaining the variance of cognitive abilities after taking SES into account or vice versa. In Economics, this is called the *ceteris paribus* principle, holding everything else constant. In the situation of mediating variables, however, the aim is not to hold everything else constant but only those factors that are not ultimately caused by the exposure, which in this case is early-life SES. The coefficients in linear regression carry information about the covariances of the explanatory variables and the dependent variable and thus estimating models with no mediating variables included and models with mediating variables included can give some clues into whether a variable is likely to be a mediator or not. This is the empirical strategy of this thesis.

There is, however, a further problem with bias that especially concerns the anthropometric variables used as mediators. Anthropometric measurements at different points in time do not carry information only on the nutritional status of that isolated period but also reflect earlier time periods. A sudden and short-lasting insult to growth may be in some cases caught up later, but the insults to growth in this thesis are not assumed to be sudden and short-lasting but more likely subtle and cumulative. Thus for example controlling for height in childhood and height in adulthood essentially means only comparing those individuals who had the same height in childhood but different heights in adulthood and vice versa. This could be interesting in its own right, if not adding the complication of socioeconomic status that likely affects both of these height measures. Controlling for both of these measures in one model can lead to another form of bias, collider bias. This refers to a situation of conditioning on a common outcome of two variables or a descendant of this outcome.<sup>355</sup> This situation is depicted in figure 3 for height. The red paths in the figure denote bias created by controlling for a common outcome of socioeconomic status and height in childhood.

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<sup>355</sup> Elwert 2013, 251. A descendant means a variable causally following the previous variable.



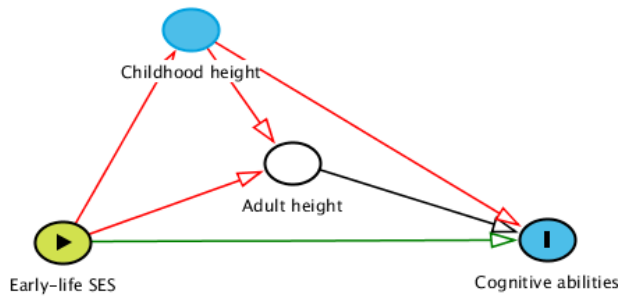


Figure 3: Collider bias with height.

Collider bias also complicates the examination of birth variables as mediators. Birth weight is a measure of intrauterine growth, but it is also drastically influenced by gestational age. Both are in turn influenced by SES, likely partly jointly and partly independently. Thus controlling for birth weight in the presence of gestational age leads to the same kind of collider bias as with height. This is depicted in figure 4. Because of this problem of collider bias that complicates the interpretation of mediation, the anthropometric mediators of socioeconomic status are mostly looked at individually in the empirical part of this thesis and not combined in a comprehensive model. This means that their joined contribution as mediators of SES is impossible to estimate with OLS. That will be the task later with the structural model that is presented in the next section.

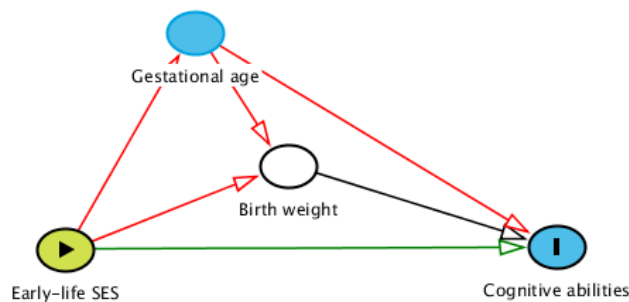


Figure 4: Collider bias with gestational age and birth weight.

A further complication with collider bias is that the age of performing the cognitive test in this thesis varies. Since this likely affects the test result, it is important to control for the age at testing. The age at testing is the same as the age at performing

the mandatory military service and this creates a further problem: the age of military service is likely influenced by education, since those continuing education may delay their military service more than those with only compulsory education. Since in the 1950s compulsory education ended already before the age of 15, it was not likely to affect the age at military service, while secondary and tertiary education may have done so. This is also reflected in the sample of this thesis, in which nearly all of those with education “unknown” have performed the test before the age of 22, while a sizeable proportion of the educated have performed the test after this age: the 95th percentile is 24.3 years for the educated and 21.7 years for the non-educated. Thus the age at conscription can also serve as a collider, as depicted in figure 5.

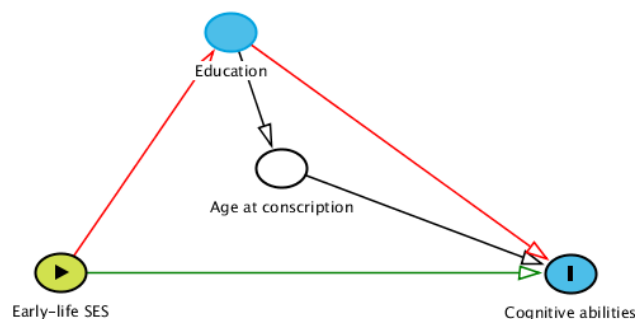


Figure 5: Collider bias with education and age at testing.

Since the mean and median age of performing the test are close to each other for the educated and the ones with unknown education, this problem may not be as severe as with the more intimately connected anthropometric variables, but should be taken into account. Thus results with the mediating effect of education are presented both with and without the age at conscription. In addition, being evacuated abroad during WW2 can be a common outcome of early-life SES and not being firstborn, and education can be the outcome of both. Thus controlling for education or evacuation status might also induce collider bias. This is why the models presented in 5.3 add variables sequentially, starting from being firstborn, because it is not a common outcome of two other variables. Then the theoretically most important mediator, education, is added, followed by the other covariates.

## 5.2 *The structural model*

Due to the problems of over-control and collider bias, the total effect of early-life SES should ideally be modeled in a more comprehensive way. Structural equation modeling (SEM) is useful for examining mediating pathways from exposure to outcome and requires a hypothesized causal structure to be laid out to estimate the model, which is often not explicitly done in studies using linear regression.<sup>356</sup> With the method it is possible to estimate both direct and indirect associations through the mediating variables. When the direct and indirect paths from exposure to outcome are added together, the total effect of the exposure to outcome can be estimated. SEM can also incorporate latent factors and thus deal with measurement error to some extent, when several indicators are used for one factor. Latent factors have often been used for both cognitive abilities and socioeconomic status. For cognitive abilities this is theoretically sensible, because of the strong correlation of performance in different tests, but for socioeconomic status it may not be as useful, since the different dimensions may have different effects.

Figure 6 presents the DAG for the structural model. This model operationalizes the concept of the developmental environment presented in Chapter 2. It includes measured proxies that reflect nutritional status in infancy and childhood as well as a very crude proxy for cognitive stimulation by education. All of these are, in turn, proxies for brain development. This model will be used later as the baseline for creating the structural equation model. For simplicity, all different growth time points are not added.

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<sup>356</sup> About SEM, see for example Schumacker & Lomax 2010; Blunch 2008; Kremlberg 2011, 359–419; Töttö 2012, 225–274.

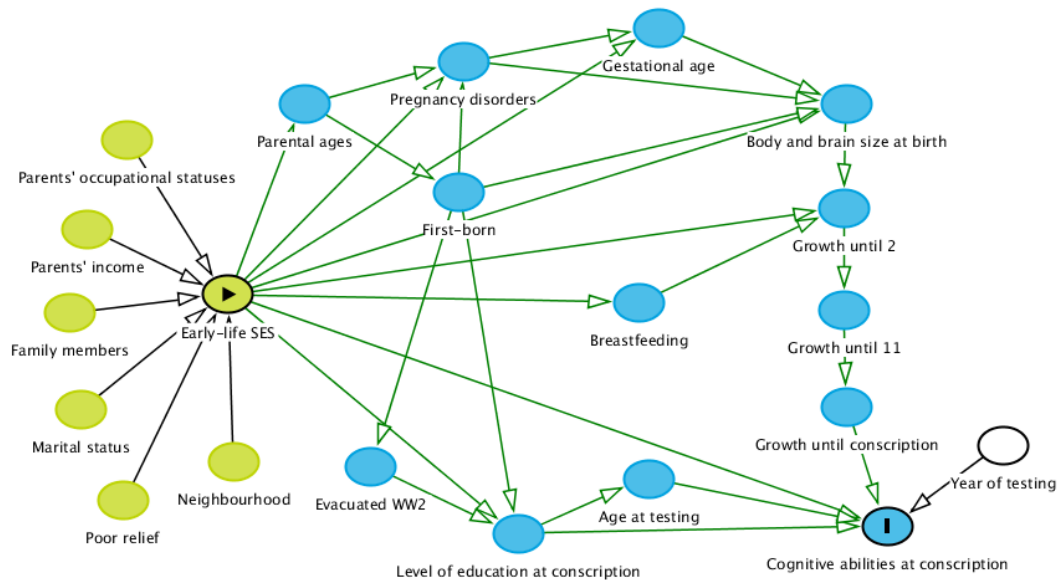


Figure 6: Baseline structural model.

The notable feature is that there is no information on parental cognitive abilities and this is likely to cause bias, because these traits are likely to directly affect both the cognitive development of the child and the socioeconomic status of the parents. If parental cognitive abilities work both by influencing their SES as well as independent of SES, the omission of this variable will cause bias and should be controlled for. If, however, the effect of parental cognitive abilities works entirely through their SES, not adjusting for it would not introduce bias. This extreme case is not likely. In light of the theory presented, however, it is not as clear as has been suggested that parental IQ should be controlled for, when the mechanisms of their brain development are not known. To the extent that parental IQ reflects unmeasured intergenerational components of SES, controlling for it might underestimate the importance of SES. If, on the other hand parental IQ mostly reflects genetic causes, the bias created might be substantial. The ideal situation would be to compare models with this variable included and not included. For example, Guo & Harris control for maternal IQ in their analysis and find that it has both direct and indirect effects through their latent variables.<sup>357</sup> Their model does not, however, examine whether maternal IQ has an effect on poverty, which could be plausible. This, in turn could be related to the life course SES of the mother herself, the composition of the household where she grew up and the position of women in society at the time. Intergenerational life-course analyses with genetic and

<sup>357</sup> Guo & Harris 2000.

epigenetic components would most likely be needed in order to shed more light on this issue.

### 5.3 Multiple regression models

While recognizing that a full examination of the question of mediating variables would require a more complex model, such as the one presented above, in this thesis linear regression is used for preliminary examination. In these models, the mediating variables might suffer from collider bias, but controlling for them should not introduce collider bias into the direct relationship from the measures of early-life SES to the outcome, as depicted in figure 7.

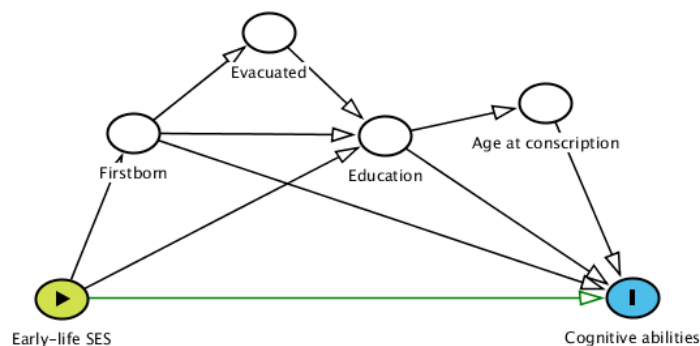


Figure 7: Empirical model

The Ordinary Least Squares (OLS) regression estimates the conditional population mean by minimizing the sum of squared residuals. The critical assumption for unbiasedness in OLS is that in the population model the errors are not correlated with any of the explanatory variables, also called the zero conditional mean assumption.<sup>358</sup> This assumption is clearly violated in this thesis because many of the unobserved influences on cognitive ability are likely to be correlated with socioeconomic status. Thus the results using multiple regression do not necessarily have a causal interpretation and attention should be paid to how the coefficients change when introducing the mediating variables. The multiple regression results are reported with heteroscedasticity-consistent standard errors, a practice widely adopted in econometrics. These standard errors do not assume a constant error variance and

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<sup>358</sup> Wooldridge 2013, 23.

provide accurate hypothesis tests and confidence intervals with minimal assumptions about the data and model.<sup>359</sup>

Several dummy-variables are used to capture effects of binary variables, such as education and being evacuated abroad during WW2. These dummy variables can be interpreted as changes in the intercepts for the group for which the dummy takes the value 1 as opposed to the reference group.<sup>360</sup> Statistical significance of the individual coefficients has been tested with the t-test and the overall significance of the regression with the F-test.<sup>361</sup> T- and F-values are not reported, but the tables in the results chapter indicate the significance level by two standards,  $p < 0.10$  and  $p < 0.05$  for those coefficients that meet this criteria.<sup>362</sup> The coefficient of determination,  $R^2$ , is also reported. It is interpreted as the proportion of the sample variation of the outcome the explanatory variables are able to explain.<sup>363</sup> For some of the models, standardized (Beta) coefficients are also reported. These allow for a better comparison of the effect sizes of each variable, because they are measured in the same standard deviation units. A Beta coefficient is a regression coefficient scaled by multiplying it with the ratio of the standard deviation of the explanatory variable in question to the standard deviation of the dependent variable. It is interpreted as how much of a standard deviation the dependent variable changes when the explanatory variable increases by one standard deviation or how much belonging to the group denoted by a dummy variable changes the score on average with respect to the reference category.<sup>364</sup>

In chapter 6 the OLS results are presented sequentially, starting with the socioeconomic status variables and proceeding to some of the mediating variables. The analyses were performed in Stata. The main socioeconomic variable used is the income estimate<sup>365</sup>, because this is the first study to use this information, while the classification of father's occupational status has been used before. The first model includes only the income estimate as a proxy for early-life income.

$$(1) \quad y = \alpha + \beta_1 \text{income} + \varepsilon,$$


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<sup>359</sup> Angrist & Pischke 2009, 45.

<sup>360</sup> For example, Feinstein & Thomas 2002, 280–289; Wooldridge 2013, 217–238 and Angrist & Pischke 2009, 48–51. Some interaction terms for the dummies have also been explored but not reported in this thesis since they did not markedly alter the results the conclusions are based on.

<sup>361</sup> For example, Wooldridge 2013, 110–148.

<sup>362</sup> Exact p-values are not reported in order to not complicate the tables too much, but can be computed from the standard errors presented.

<sup>363</sup> For example, Wooldridge 2013, 76–77. Since additional variables nearly always increase the variation explained, too much emphasis should not be placed on small changes in this statistic

<sup>364</sup> For example, Feinstein & Thomas 2002, 243–245 and Wooldridge 2013, 181–183.

<sup>365</sup> In the methods and results section, the term income estimate is used for brevity to refer to the taxable income in thousands of 1928 Finnish marks.

where  $y$  is the cognitive test total score, “income” is parental taxable income in thousands of 1928 Finnish marks,  $\alpha$  is the intercept,  $\beta_1$  the regression coefficient of income and  $\varepsilon$  the error term. After estimating (1), the first mediator, a dummy for being firstborn, is added, because it is not likely to suffer from collider bias.

$$(2) y = \alpha + \beta_1 \text{income} + \beta_2 \text{firstborn} + \varepsilon$$

Next, one of the likely most important mediators, education, is added as a dummy variable denoting at least upper secondary education, with the caveats presented in 4.6 kept in mind. Then an important covariate of education, age of testing is added. Finally, a dummy for being evacuated abroad during the Second World War is included, since it is also likely to be a mediator. These models are presented below.

$$(3) y = \alpha + \beta_1 \text{income} + \beta_2 \text{firstborn} + \beta_3 \text{educated} + \varepsilon$$

$$(4) y = \alpha + \beta_1 \text{income} + \beta_2 \text{firstborn} + \beta_3 \text{educated} + \beta_4 \text{age} + \varepsilon$$

$$(5) y = \alpha + \beta_1 \text{income} + \beta_2 \text{firstborn} + \beta_3 \text{educated} + \beta_4 \text{age} + \beta_5 \text{evacuated} + \varepsilon$$

In addition, models (1)–(5) were analyzed instead of the income estimate with father’s maximal achieved occupational status in childhood in three categories: senior clerical, junior clerical and manual worker, which is the reference category. Models (1) and (5) were also analyzed with both the income estimate and occupational statuses together:

$$(6) y = \alpha + \beta_1 \text{income} + \beta_2 \text{juniorclerical} + \beta_3 \text{seniorclerical} + \varepsilon$$

$$(7) y = \alpha + \beta_1 \text{income} + \beta_2 \text{juniorclerical} + \beta_3 \text{seniorclerical} + \beta_4 \text{firstborn} + \beta_5 \text{educated} + \beta_6 \text{age} + \beta_7 \text{evacuated} + \varepsilon$$

After presenting the models for the total scores, the results are presented with models (1), (5), (6) and (7) for the outcomes of the visuospatial, arithmetic and verbal subtests each as the dependent variable.

After the basic models, models with the anthropometric variables are reported. The results are presented for each anthropometric variable individually, because of the complications of collider bias. First the issue is approached by adding the variables to model (6) to see whether the coefficients of the socioeconomic variables change by introducing anthropometrics. Then they are also added to model (7). The different anthropometric variables used are height at conscription and at seven years of age, as well as height, weight and BMI at two years of age.

Dummy variables were also created for birth years and the years of testing, but since they did not alter the results and are intimately linked with the age of testing, they are not included in any of the models.<sup>366</sup> A short discussion is provided in section 6.5.

#### *5.4 Non-linearities and censoring*

In order to capture non-linear effects, income was also examined by dividing it in quintiles and using these quintiles as dummy variables.<sup>367</sup> The omitted reference category is the first, poorest, quintile. Thus the coefficients of the other quintiles represent the average difference to the average test scores in the first quintile. The models reported are equivalent to (1) and (5), apart from the income estimate that is replaced by the quintiles 2–5.

Finally, it should also be noted that there might be a problem of censoring in the cognitive test results: in two of the subtests, some individuals have answered correctly to all questions and thus received the maximum number of points for that section. In the verbal test seven individuals and in the arithmetic test 13 individuals have reached the maximum points. Thus also their total points might underestimate their cognitive ability with respect to others, since they may have had scored differently, had there been more questions to answer. No one reached the maximum points in the visuospatial subtest, which is the most equivalent to other cognitive tests that measure general intelligence. Tobit models can deal with censored dependent variables, but they are not employed in this thesis because of the added difficulty in interpretation.<sup>368</sup> Because of the relatively low number of individuals with maximum points and no one with maximum points on more than one test, censoring should not have a large effect on the estimates.

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<sup>367</sup> About non-linearities, see for example, Wooldridge 2013, 39–42 & 704–710.

<sup>368</sup> For example, Wooldridge 2013, 585–589.



## 6 RESULTS

This chapter first presents some descriptive statistics and compares known differences between included and excluded subjects. Then it presents the multiple regression results with the income estimate and father's occupational status as measures of early-life socioeconomic status. It also takes a preliminary look at the question of mediation with the anthropometric variables.

### 6.1 Descriptive statistics

Figure 8 presents the distribution of the cognitive test total scores in the sample of this thesis. Figure 9 presents the distributions in four groups by parental income in childhood. The distributions in this figure are presented in percentages in order for the different groups to be comparable. The two highest income quartiles have more high scorers than the other quartiles and thus their distributions are left-skewed.

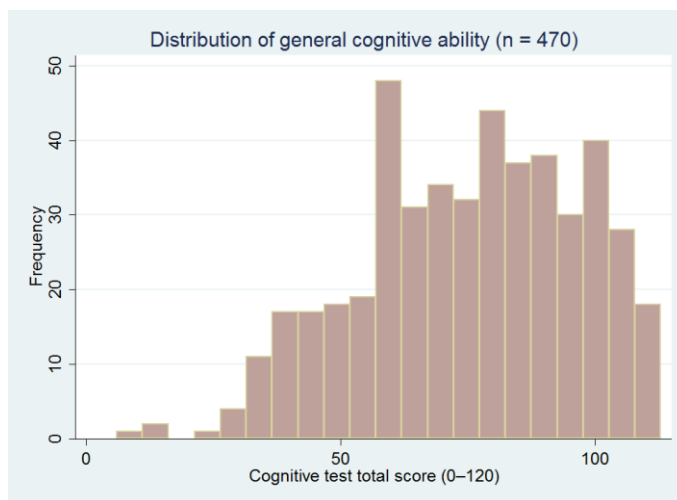


Figure 8: Distribution of the general cognitive ability score in the sample.

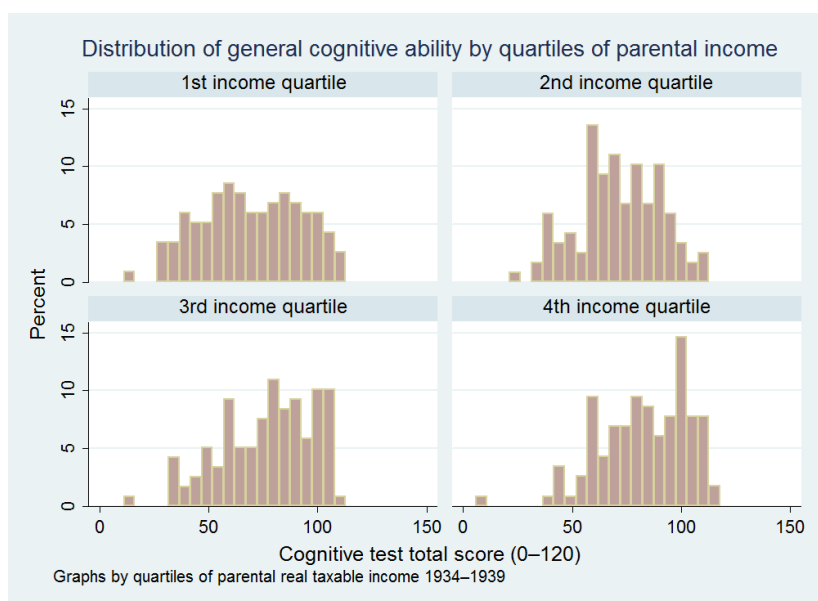


Figure 9: Distributions of the general cognitive ability score in four groups by parental income.

Table 3 presents descriptive characteristics of men included in the sample of this thesis compared to men born 1934–1939 and included in the Helsinki Birth Cohort. The included subjects seem to be slightly more often educated, have more often a senior clerical father and have higher cognitive test scores. The anthropometric characteristics are very similar.

**Table 3. Characteristics of men in the sample compared to the Helsinki Birth Cohort**

Characteristic	Sample 1934–1939 (n = 473)	HBCS 1934–1939 (n = 2100)
Father manual worker (%)	59.7 (n = 464)	61.8
Father senior clerical worker (%)	15.5 (n = 464)	14.1
Mean of cognitive test total score	75.23 (n = 470)	72.65 (n = 683)
Mean age at cognitive test	20.3	20.2 (n = 689)
At least upper secondary education (%)	58.1 (n = 461)	53.5 (n = 1945)
First-born (%)	55.2	52.0
Evacuated in WW2 (%)	27.4 (n = 456)	27.4
Adult height (cm)	176.0	176.1 (n = 1076)
Height at 7 years of age (cm)	119.6 (n = 342)	119.7 (n = 1415)
Weight at 2 years of age (kg)	12.3	12.3
Birth weight (kg)	3.4	3.4

Notes: Occupational information comes from birth, child welfare clinic and school records. Cognitive test score is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. Education comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives. Anthropometrics come from birth, child welfare clinic, school and military records. The number of subjects is presented for the sample, when it is less than 473 and for the cohort, when it is less than 2000.

Table 4 presents the availability of cognitive data for the men born 1934–1939 and included in the Helsinki Birth Cohort, as well as the number and percentage of these men included in the sample of this thesis. As described in section 4.1, the most common reason not to be included in the sample is that the income information for the parents was not found.

**Table 4. Availability of cognitive and income data by birth year**

Birth year	HBCS (n)	Sample (n)	Percentage
1934	11	11	100
1935	84	59	70.2
1936	127	96	75.6
1937	136	95	69.9
1938	146	103	70.5
1939	185	109	58.9
Total	689	473	68.7

Table 5 presents the means of the first available parental taxable income from the tax records for both the sample and the cohort. The sample means are slightly higher for tax years 1934–1936 and 1939.

**Table 5. Mean of parents' first available real taxable income by the tax year included in the sample (thousands 1928 FIM)**

Tax year	Sample	Cohort
1934	15.3	12.7
1935	23.6	19.2
1936	21.4	20.8
1937	24.1	24.1
1938	26.7	26.7
1939	24.8	21.4

Figures 10 and 11 present the distributions of the sum of parent's real taxable incomes in the sample, as well as mother's real taxable income. The sum of parents' taxable incomes is zero for 33 families. Those who have zero income are not included in the figure for mothers, since including them would make the figure very difficult to read. 150 mothers have taxable income greater than zero in the sample. The income distribution of the fathers is not shown separately, because the correlation between father's income and the sum of both parent's income is 0.97.

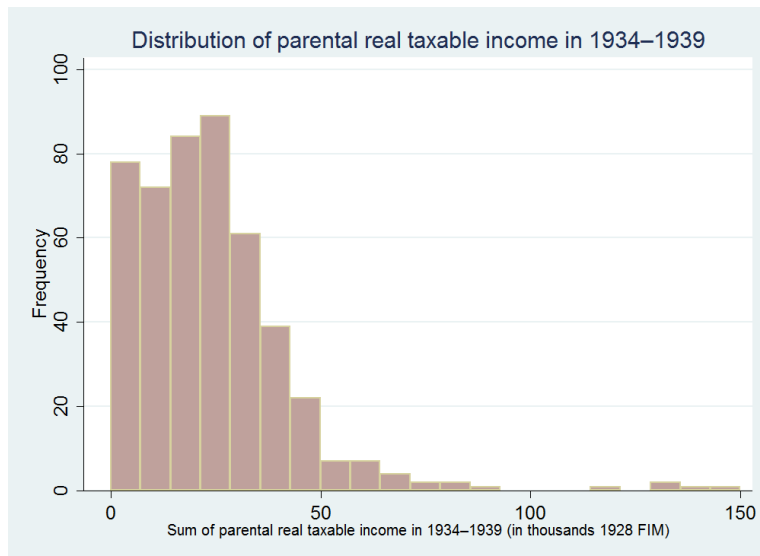


Figure 10: Distribution of parental income in childhood.

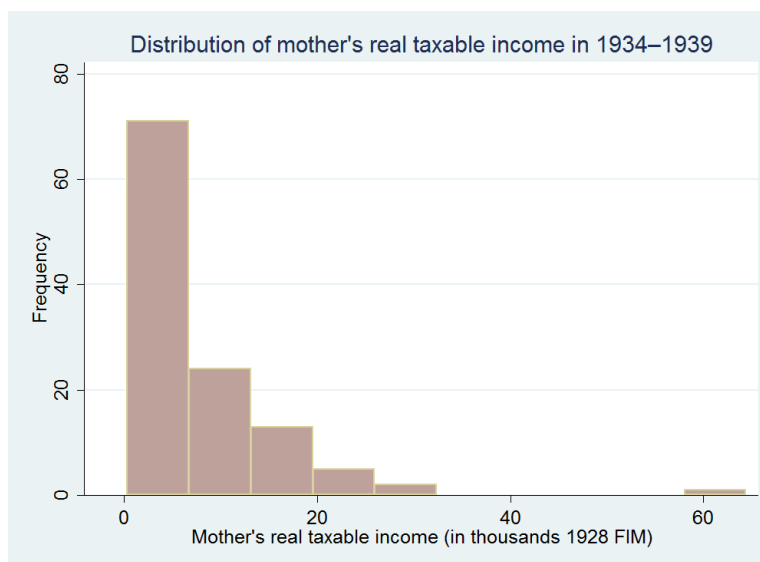


Figure 11: Distribution of mother's income in childhood.

Table 6 presents Pearson's product-moment correlation coefficients for some of the continuous study variables. The subtest scores have high correlations with the total score, as expected. Parental income is correlated with all scores. Age at test is correlated with the scores but not with parental income. Anthropometrics are correlated with both the cognitive scores and parental income.

**Table 6. Correlations of some key variables**

	Cognitive ability total score	Parental income 1934–1939
Cognitive ability total score		0.26
Visuospatial score	0.82	0.20
Arithmetic score	0.91	0.23
Verbal score	0.86	0.24
Age at test	0.25	0.02
Adult height	0.17	0.09
Height at 7 years of age	0.13	0.13
Weight at 2 years of age	0.18	0.10
Notes: Cognitive test scores come from the Finnish Defence Forces Basic Ability test. Total score is the sum of subtest scores. The sum of parents' taxable income comes from Helsinki municipal tax records. Anthropometrics come from birth, child welfare clinic, school and military records.		

## 6.2 Income, father's occupational status and general cognitive ability

Multiple regression results for the general cognitive ability test score and the income estimate are presented in table 7. The maximum points in the test are 120.

Heteroscedasticity-consistent standard errors are in parentheses. The last column shows the standardized coefficients for model 5, expressed in standard deviation units.

**Table 7. Childhood income and adult general cognitive ability**

Explanatory variable	(1)	(2)	(3)	(4)	(5)	Beta (5)
Parental taxable income (thousands FIM)	0.29** (0.05)	0.29** (0.05)	0.21** (0.04)	0.21** (0.04)	0.20** (0.04)	0.18**
First-born		5.49** (1.90)	3.28** (1.71)	2.65 (1.73)	2.20 (1.77)	0.05
At least upper secondary education			18.69** (1.77)	17.83** (1.80)	18.12** (1.82)	0.42**
Age at test				1.79** (0.49)	1.84** (0.51)	0.12**
Evacuated abroad during WW2					-2.69 (1.88)	-0.06
Intercept	68.29** (1.56)	65.15** (1.84)	57.74** (1.79)	22.25** (9.71)	22.07** (10.03)	
R <sup>2</sup>	0.07	0.09	0.27	0.28	0.29	
n	470	470	458	458	441	
** p < 0.05, * p < 0.10						
Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives.						

As table 7 demonstrates, the coefficient of the income estimate is considerably lower, when the mediating variables are controlled for. Adding the education variable lowers the coefficient of the income estimate the most, suggesting that education could be an important mediator, though no causality can be established. When it comes to education, the coefficient is consistent in all of the models: slightly lower when covariates are taken into account but of similar magnitude.<sup>369</sup> In comparable standard deviation units education has by far the largest effect on the cognitive test scores: having at least upper secondary education compared to unknown education predicts a 0.42 standard deviations higher score on average. Being firstborn seems to be slightly advantageous in terms of cognition, but is not statistically significant when the other covariates are included. Conversely, being evacuated during World War 2 seems to be associated with slightly lower scores, but it is not statistically significant either.<sup>370</sup> Age at test is significantly associated with cognitive performance, and the comparable magnitude is slightly lower than for the direct effect of the income estimate in SD units. The possibility of collider bias should, however, be kept in mind.<sup>371</sup>

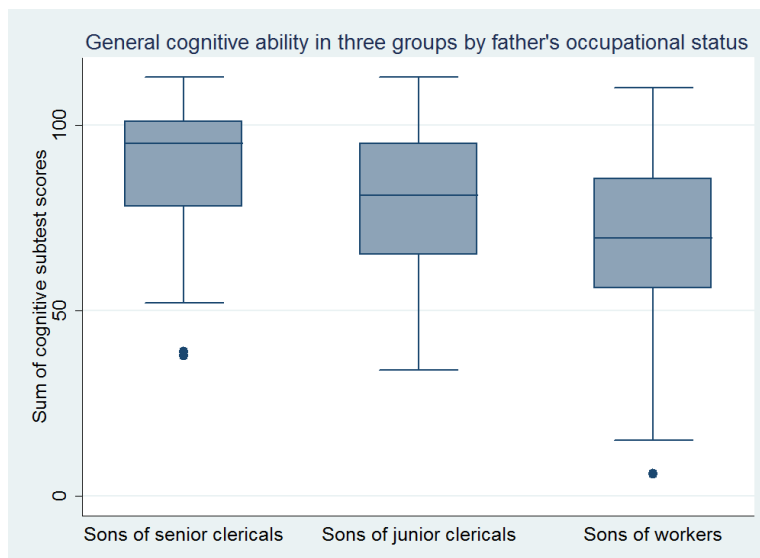


Figure 12: Son's general cognitive ability in three groups by father's occupational status.

<sup>369</sup> If entered into the regression with only the income estimate, the coefficient is 19.09 ( $p < 0.001$ ).

<sup>370</sup> When entered individually into the regression with the income estimate, the coefficient is -2.86, but not statistically significant ( $p = 0.18$ ).

<sup>371</sup> Alone in a model with the income estimate the standardized coefficient for age is notably higher, 0.22 and likely picks up more of the effect of education than in the model where both are included.

**Table 8. Adult cognitive abilities and father's occupational status**

Explanatory variable	(1)	(2)	(3)	(4)	(5)	Beta (5)
Father junior clerical	8.79**	8.24**	6.00**	4.69**	4.65**	0.09**
	(2.18)	(2.27)	(2.03)	(2.03)	(2.05)	
Father senior clerical	18.52**	18.08**	13.58**	13.52**	13.04**	0.22**
	(2.61)	(2.63)	(2.50)	(2.46)	(2.60)	
First-born		3.04	1.55	0.94	0.66	0.02
		(1.99)	(1.78)	(1.80)	(1.84)	
At least upper secondary education			17.94**	17.13**	17.40**	0.40**
			(1.87)	(1.89)	(1.92)	
Age at test				1.84**	1.85**	0.12**
				(0.50)	(0.51)	
Evacuated abroad during WW2					-2.79	-0.06
					(1.88)	
Intercept	70.01**	68.56**	60.41**	24.02**	24.65**	
	(1.27)	(1.51)	(1.71)	(9.86)	(10.14)	
R <sup>2</sup>	0.10	0.11	0.28	0.29	0.30	
n	462	462	450	450	433	

\*\* p < 0.05, \* p < 0.10

Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives.

The models with father's occupational status as the SES measure are presented in table 8 and figure 12. In the figure the boxes show the interquartile range and the line inside the box denotes the median in the group. The whiskers show the rest of the range and the dots denote outliers. Similarly to the income estimate, the occupational dummies are lower when the mediating variables are added to the model, suggesting the possibility of mediation. The coefficients on education, age at testing and evacuation status are very similar to the coefficient in the models with income. The only clear difference is with the first-born variable that may be differently related to the different occupational categories than to income as a continuous variable. It is, however, not statistically significant in any of the models, though the possibility of collider bias should be kept in mind. Another difference to the effect of income is that there seems to be a non-linear effect between the occupational categories: the effect of having a senior clerical father is considerably higher than for a junior clerical father on average. Whether this non-linearity is present in the income estimates as well is presented in table 9 and in figure 13 by dividing the income estimate into quintiles. The reference category is the first, poorest, income quintile.

**Table 9. Childhood income in quintiles and cognitive abilities in adulthood**

Explanatory variable	Model 1	Beta (1)	Model 5	Beta (5)
Taxable income in the second quintile	3.29	0.06	1.74	0.03
	(3.08)		(2.80)	
Taxable income in the third quintile	7.28**	0.14**	5.53**	0.10**
	(3.23)		(2.78)	
Taxable income in the fourth quintile	9.13**	0.17**	4.99*	0.09*
	(3.29)		(3.01)	
Taxable income in the fifth quintile	17.24**	0.32**	11.99**	0.22**
	(3.15)		(2.89)	
First-born			1.95	0.05
			(1.78)	
At least upper secondary education			17.98**	0.41**
			(1.85)	
Age at test			1.81**	0.12**
			(0.51)	
Evacuated abroad during WW2			-2.76	-0.06
			(1.88)	
Intercept	67.88**		22.97**	
	(2.44)		(10.37)	
R <sup>2</sup>	0.07		0.29	
n	470		441	

\*\* p < 0.05, \* p < 0.10

Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives.

There seems to be a slight non-linearity for the income quintiles: the first two quintiles seem to be quite close to each other on average, but the variability is much greater in the first quintile than in the second. Then again the third and fourth quintiles seem to be roughly similar, both on average and in terms of the variability of scores, especially when education is taken into account. It could be interpreted as a “middle class” in terms of income and cognitive ability. Then the fifth quintile seems to have distinctly higher scores. This picture is roughly similar to the one given by the occupational categories, where sons of senior clericals seem to form a distinctive group.



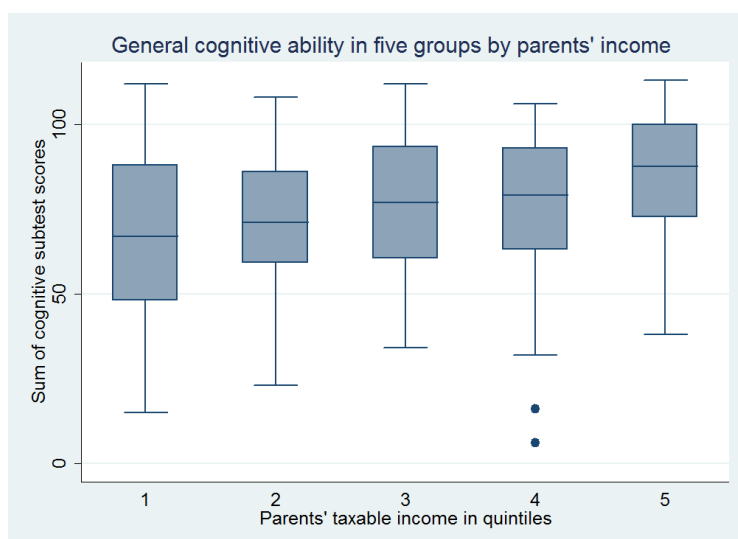


Figure 13: Son's general cognitive ability score in five groups by parents' income.

While the different proxies for socioeconomic status imply roughly similar effects and mediators, they do not seem to measure exactly the same thing: when income is regressed on the clerical dummies, occupational status is only able to explain about 15 per cent of the variation in income.<sup>372</sup> Income differences inside the working class could explain more of the variation and thus this issue can be examined in more detail later with a more fine-tuned occupational classification.

When included in the same model in Table 10, both income and the occupational dummies are statistically significant, although junior clerical status loses its significance, when the other covariates are added.<sup>373</sup> Education is again the strongest predictor and the effect only slightly smaller than when the SES measures are included separately. Father's senior clerical status seems to be again a distinctive category, predicting 0.17 SD units higher cognitive test scores, even when income and education are held constant. It should be noted however, that income at birth may be considerably less than income later in childhood for these families, since occupational status is the maximum of all the records until 11 years of age for some of the families. Thus the fathers may not have yet reached their senior status at this point in time or their salary may be proportionally higher later. If the clerical dummies are taken from birth

<sup>372</sup> If the occupational dummies are added from birth records and thus corresponding closer to the time point of income measurement for most families, the percentage of variance explained is slightly higher, 20 per cent.

<sup>373</sup> Income and junior clerical status are jointly significant ( $p = 0.049$ ), however.

records, the coefficients for the clerical dummies are indeed higher and the income estimate is no longer statistically significant at the 5 per cent level ( $p = 0.086$ ).<sup>374</sup>

**Table 10. Childhood income, father's occupational status and cognitive abilities**

Explanatory variable	(6)	Beta (6)	(7)	Beta (7)
Parents' real taxable income	0.18**	0.16**	0.15**	0.13**
	(0.05)		(0.04)	
Father's occupational status junior clerical	7.23**	0.15**	3.40	0.07
	(2.16)		(2.06)	
Father's occupational status senior clerical	14.74**	0.25**	10.11**	0.17**
	(2.81)		(2.70)	
First-born			1.03	0.02
			(1.83)	
At least upper secondary education			16.86**	0.39**
			(1.90)	
Age at test			1.91**	0.13**
			(0.50)	
Evacuated abroad during WW2			-2.09	-0.04
			(1.88)	
Intercept	66.57**		20.59**	
	(1.59)		(9.88)	
R <sup>2</sup>	0.13		0.31	
n	462		433	
** $p < 0.05$ , * $p < 0.10$				

Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives.

### *6.3 Early-life socioeconomic status & visuospatial, arithmetic and verbal abilities*

Table 11 presents the results for the income estimate and each of the cognitive subtests. In these tests the maximum points are 40.

<sup>374</sup> This analysis includes 15 subjects less and is able to explain slightly less of the variance in the test scores, 29 per cent.

Explanatory variable	Visuospatial test			Arithmetic test			Verbal test		
	(1)	(5)	(6)	(7)	Beta (7)	(1)	(5)	(6)	Beta (7)
Parents' real taxable income	0.060** (0.016)	0.043** (0.015)	0.033** (0.015)	0.028* (0.016)	0.09* (0.07)	0.122** (0.021)	0.087** (0.018)	0.081** (0.021)	0.13** (0.018)
Father junior clerical			1.73** (0.62)	0.93 (0.63)	0.07			2.34** (1.11)	0.02
Father senior clerical			3.57** (0.83)	2.42** (0.83)	0.15**			6.14** (1.16)	0.13**
First-born		0.96* (0.52)		0.66 (0.54)	0.06		0.39 (0.87)		0.00
At least upper secondary education		4.12** (0.53)		3.80** (0.56)	0.32**		8.45** (0.91)		0.39**
Age at test		0.38** (0.17)		0.42** (0.16)	0.10**		0.70** (0.25)		0.11**
Evacuated abroad during WW2		-0.09 (0.58)		0.04 (0.58)	0.00		-0.74 (0.96)		-0.03
Intercept	22.31** (0.45)	12.04** (3.31)	21.92** (0.46)	11.27** (3.21)		22.24** (0.74)	4.06 (5.05)	21.57** (0.78)	2.35 (4.97)
R <sup>2</sup>	0.04	0.19	0.08	0.21		0.05	0.25	0.10	0.26
n	473	444	464	435		470	441	462	433
** p < 0.05, * p < 0.10									
Notes: The dependent variable is the Finnish Defence Forces Basic Ability test subtest score. Maximum points are 40 in each test.									
The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks.									
Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker.									
Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives.									

Childhood income predicts the arithmetic and verbal scores better than the visuospatial score. The visuospatial test is supposed to be less connected to crystallized intelligence and acquired knowledge and more to fluid intelligence. It is often the test used for cross-cultural comparisons, since it does not require literacy or knowledge of mathematical concepts. Thus it is supposed to be less affected by education or the amount of reading or performing calculations. This is controversial, however, because the Flynn effect is the strongest for these types of tests and thus one would have to assume that education is not one of the causal factors driving the secular trend. Flynn himself does not believe this, but thinks of education as an integral part of promoting the abstract way of thinking required to succeed in these kinds of tests.<sup>375</sup> Compatible with his view, in this sample education seems to be a good predictor, although reverse causality might be at play. Since the effect of income is stronger when education is not taken into account, there is also a possibility of mediation by education, even if it would be less than for the other two tests that measure clearly education-related skills.

A notable feature about the verbal scores is that evacuation status is now statistically significant and the effect is negative. It has also been previously reported that the verbal tests of the evacuees suffered the most compared to the not evacuated.<sup>376</sup> This is not surprising, because the separation meant living in an environment with a different language during the period of separation for most children. The association was strongest for those separated the longest, likely because their re-adaptation to the Finnish language was more difficult than for those separated for a shorter period. It is also more difficult to learn a language at higher ages.

#### *6.4 Anthropometrics as mediators*

Table 12 presents results for adult height. It is a significant predictor of the cognitive ability total score in model (6) with only the socioeconomic variables, but loses its statistical significance, when the other covariates are added. This suggests that height indeed could be a mediator between socioeconomic status and education, as the height differences of school children in different types of schools discussed in section 3.3 imply.

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<sup>375</sup> Flynn 2012.

<sup>376</sup> Pesonen et al. 2010.

**Table 12. Adult height and general cognitive ability**

Explanatory variable	(6)	Beta (6)	(7)	Beta (7)
Parents' real taxable income	0.171**	0.16**	0.142**	0.13**
	(0.047)		(0.041)	
Father junior clerical	7.00**	0.14**	3.34	0.07
	(2.16)		(2.07)	
Father senior clerical	14.34**	0.25**	10.03**	0.17**
	(2.80)		(2.71)	
Adult height (cm)	0.459**	0.14**	0.207	0.06
	(0.138)		(0.144)	
First-born			1.07	0.02
			(1.83)	
At least upper secondary education			16.52**	0.38**
			(1.94)	
Age at test			1.84**	0.12**
			(0.51)	
Evacuated abroad during WW2			-2.00	-0.04
			(1.88)	
Intercept	-13.93		-14.17	
	(24.3)		(25.73)	
R <sup>2</sup>	0.15		0.31	
n	462		433	
** p < 0.05, * p < 0.10				
Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives. Height comes from military conscription records.				

Table 13 presents the results for height at seven years of age.<sup>377</sup> The most interesting feature about the results is that when height at seven years is controlled for, evacuation status during WW2 becomes a strong and highly statistically significant predictor of general cognitive ability. This means that for those who had similar height at seven years of age, the ones who stayed in Finland fared better in the cognitive tests in adulthood. This point of height measurement happened during the war for almost all birth years, although imputation may be more frequent for those evacuated if they did not attend school in Helsinki that year. When the different subtests are analysed separately, the effect is only statistically significant for the verbal scores (data not shown). Thus this result could be driven by the verbal test. Including dummies for birth years does not change the effect (data not shown).

<sup>377</sup> The estimates are very similar for weight, while the estimates for BMI are very far from being statistically significant.

**Table 13. Height at seven years of age and general cognitive ability**

Explanatory variable	(6)	Beta (6)	(7)	Beta (7)
Parents' real taxable income	0.116**	0.11**	0.091*	0.09*
	(0.051)		(0.048)	
Father junior clerical	5.40**	0.11**	2.10	0.04
	(2.53)		(2.40)	
Father senior clerical	14.72**	0.26**	10.41**	0.18**
	(2.96)		(2.92)	
Height at seven years of age (cm)	0.542**	0.12**	0.382*	0.09*
	(0.231)		(0.224)	
First-born			0.82	0.02
			(2.05)	
At least upper secondary education			16.27**	0.39**
			(2.09)	
Age at test			1.52**	0.10**
			(0.66)	
Evacuated abroad during WW2			-5.22**	-0.11**
			(2.19)	
Intercept	3.98		-13.47	
	(27.50)		(29.11)	
R <sup>2</sup>	0.12		0.32	
n	336		313	
** p < 0.05, * p < 0.10				
Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives. Height comes from school records.				

Tables 14, 15 and 16 present the results for height, weight and BMI at 24 months of age. They show that higher values of each anthropometric variable predict higher cognitive test scores, although the associations with height and BMI are not statistically significant on the 5 per cent level, when the other covariates are taken into account. Weight is the strongest predictor, a one SD increase in weight predicting about 0.13 SD higher test scores on average. Weight is not independent of height, since taller individuals tend to also weigh more on average. Thus weight also carries information on height, whereas BMI is constructed to be independent of height. This means that weight may be better able to capture the underlying concept of nutritional status than the other two measures.

**Table 14. Height at two years of age and general cognitive ability**

Explanatory variable	(6)	Beta (6)	(7)	Beta (7)
Parents' real taxable income	0.173**	0.16**	0.139**	0.13**
	(0.047)		(0.041)	
Father junior clerical	7.03**	0.14**	3.33	0.07
	(2.18)		(2.06)	
Father senior clerical	14.99**	0.26**	10.42**	0.18**
	(2.82)		(2.74)	
Height at two years of age (cm)	0.563**	0.09**	0.462*	0.07*
	(0.284)		(0.264)	
First-born			1.06	0.02
			(1.83)	
At least upper secondary education			16.79**	0.39**
			(1.91)	
Age at test			1.86**	0.12**
			(0.51)	
Evacuated abroad during WW2			-1.73	-0.04
			(1.90)	
Intercept	18.10		-18.41	
	(24.62)		(23.72)	
R <sup>2</sup>	0.13		0.32	
n	461		432	

\*\*  $p < 0.05$ , \*  $p < 0.10$

Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives. Height comes from child welfare clinic records.

**Table 15. Weight at two years of age and general cognitive ability**

Explanatory variable	(6)	Beta (6)	(7)	Beta (7)
Parents' real taxable income	0.165**	0.15**	0.136**	0.12**
	(0.044)		(0.040)	
Father junior clerical	6.76**	0.14**	3.22	0.06
	(2.18)		(2.07)	
Father senior clerical	14.79**	0.25**	10.37**	0.17**
	(2.77)		(2.68)	
Weight at two years of age (kg)	2.81**	0.15**	2.32**	0.13**
	(0.79)		(0.76)	
First-born			0.95	0.02
			(1.81)	
At least upper secondary education			16.35**	0.38**
			(1.91)	
Age at test			1.93**	0.13**
			(0.51)	
Evacuated abroad during WW2			-1.23	-0.03
			(1.90)	
Intercept	32.51**		-7.86	
	(9.77)		(13.30)	
R <sup>2</sup>	0.15		0.33	
n	462		433	
** p < 0.05, * p < 0.10				

Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives. Weight comes from child welfare clinic records.



**Table 16. BMI at two years of age and general cognitive ability**

Explanatory variable	(6)	Beta (6)	(7)	Beta (7)
Parents' real taxable income	0.183**	0.17**	0.148**	0.13**
	(0.046)		(0.040)	
Father junior clerical	6.91**	0.14**	3.24	0.06
	(2.17)		(2.08)	
Father senior clerical	14.34**	0.25**	9.92**	0.17**
	(2.82)		(2.69)	
BMI at two years of age	1.77**	0.10**	1.45*	0.08*
	(0.85)		(0.76)	
First-born			1.01	0.02
			(1.82)	
At least upper secondary education			16.54**	0.38**
			(1.90)	
Age at test			1.96**	0.13**
			(0.51)	
Evacuated abroad during WW2			-1.84	-0.04
			(1.89)	
Intercept	37.39**		-4.37	
	(14.06)		(16.35)	
R <sup>2</sup>	0.14		0.32	
n	461		432	
** p < 0.05, * p < 0.10				
Notes: The dependent variable is the Finnish Defence Forces Basic Ability test total score. Maximum points are 120. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Occupational information comes from birth, child welfare clinic and school records. For the occupational dummies the reference category is manual worker. Education is a dummy variable denoting known education on at least upper secondary level and it comes from Finnish census data after 1970. Evacuation status comes from records in the National Archives. BMI comes from child welfare clinic records.				

Table 17 uses weight at two years of age as the dependent variable. This time it is expressed in grams in order for the coefficient of income to be easier to interpret. It demonstrates that the income estimate predicts weight even when birthweight and gestational age are controlled for.<sup>378</sup> This further supports the idea that anthropometrics could mediate the effect of early-life socioeconomic status on cognitive abilities.

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<sup>378</sup> Including the occupational dummies does not considerably change the estimates and both dummies are far from statistically significant, individually or jointly. Not controlling for gestational age lowers the coefficient of income to 0.006 (p = 0.086), but the coefficient of birth weight stays the same. In the cohort, there are a few combinations of birth weight and gestational age that are biologically impossible. Such gestational ages have been excluded from the analysis.

**Table 17. Income and weight (g) at two years of age**

Explanatory variable	Model	Beta
Parents' real taxable income	10.20** (3.41)	0.15**
Birth weight (kg)	1031.16** (119.80)	0.44**
Gestational age (weeks)	-35.15 (29.63)	-0.06
Intercept	9940.93** (999.56)	
R <sup>2</sup>	0.20	
n	452	
** p < 0.05, * p < 0.10		

Notes: The dependent variable is weight at 24 months of age in grams. The sum of parents' taxable income comes from Helsinki municipal tax records and is expressed in thousands of 1928 Finnish marks. Birth weight and gestational age come from birth records.

### 6.5 Additional robustness checks

Since the sample subjects are born in different years, there may be cohort effects that have differential influences by birth year. Children born in different years also entered the war at different developmental ages and this could especially have had an effect on their growth, since Malmivaara has shown that growth was slower for the children who lived through the war years.<sup>379</sup> It was also hypothesized a priori that 1934 as the last depression year could have an effect. Unfortunately since the testing only became systematic towards the end of the 1950s, there are only 11 cases for the birth year 1934 and they have higher scores than in other birth years. The dummy variable for birth year 1934 was statistically significant in most models, but since it did not markedly change any of the other coefficients, it is not reported. For the other birth years the dummies were not statistically significantly different from zero in any of the models. Including them did not change the other estimates much and thus they are not reported either.

Dummies were also created for the year of testing in order to capture a possible upward trend in the test scores over time. When included in the models, the dummies only had a clear effect on the coefficient of age at testing, as expected. There was no

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<sup>379</sup> Malmivaara 1949.

clear upward trend: some of the dummies were negative and some positive, compared to the reference year 1955. Some of the years in the 1960s showed higher scores, but the number of subjects who performed the test in the 1960s is low. Moreover, only the dummy for test year 1966 was statistically significant, but this was the last test year in the data and included only one subject. Thus the test year dummies are not reported either.

## 7 DISCUSSION & CONCLUSION

This chapter first discusses cognitive stimulation and nutritional status as mechanisms of early-life socioeconomic status on cognitive abilities. It then turns to the wider implications for human capital. The last section concludes.

### *7.1 Mechanisms of early-life socioeconomic status on cognitive abilities: cognitive stimulation and nutritional status*

The results presented in the previous chapter showed that childhood socioeconomic status proxied by parents' taxable income and father's occupational status predicts cognitive abilities in adulthood. This result holds when education and other important covariates are taken into account, although they are likely to mediate the effect of socioeconomic status as well. Thus the total effect of socioeconomic status may be different when analyzed with a more comprehensive method that is able to take mediation into account. In the OLS analysis adding the other covariates lowered the estimated direct effect of SES in the models, and this could imply at least partial mediation by the covariates. While the indicator for education in this thesis is far from perfect, upper secondary education is nonetheless an exceptionally strong predictor of the cognitive test scores. The direction of causality is, however, impossible to infer: either education can cause better cognition or those who have better cognitive skills end up acquiring more education. Both directions are likely to work simultaneously, but it is also important to take the context into account.

The school system at the time of this cohort was selective and the key point of selection was at age 11 years, when children were chosen for an academic track. Since being selected required both good grades and financial investment, the child's future was largely determined by his parents' decisions and the developmental environment up to that point. If the parents either did not want to pay the school fees or did not consider the academic track important for their child, good grades would not have been enough. The cost was probably not insurmountably high for most families, but for some of the poorest it may have been too much, especially after a difficult time such as the consecutive crises of the Great Depression and the Second World War. In addition, school grades up to that point could also be affected by parental SES: possible mechanisms could include nutrition, disease and time spent doing schoolwork or other cognitively stimulating activities throughout childhood. For example, children in poorer families may have had to spend more time in household chores than children in more affluent families. From statistics in the 1930s we also know that those entering the

academic track were much taller than others.<sup>380</sup> Economic deprivation manifested in growth could have impeded school work, the likelihood of getting good grades and thus being eligible for the academic track. Indirect support to this comes from Peltola, who has found that the increase in underweight children coincided with an increase of children failing in school in Tampere during the Great Depression.<sup>381</sup>

The estimated models presented in this thesis are able to explain about 30 per cent of the variance in the cognitive test scores in adulthood. This is comparable to Silva et al., whose OLS model accounted for 27 per cent of the variation in childhood intelligence at age ten.<sup>382</sup> Their model includes significantly more anthropometric variables, but they do not take collider bias into account in their regression results. Their SEM model, on the other hand, was able to explain 34 per cent of the variation in cognitive abilities, which is not much higher than either of these regression models. As expected, in their study the total effect of socioeconomic status was noticeably higher when the mediators were taken into account. In their SEM framework, a one SD increase in the latent socioeconomic status indicator predicted 0.56 SDs higher cognitive ability as opposed to only 0.29 SDs higher in the multiple regression estimates.

In this thesis, the association of each anthropometric variable with cognitive abilities is attenuated by introducing the other covariates. It is important to note, however, that this does not necessarily mean they have no causal influence: first of all, growth measured at one point does not tell the whole story, and growth trajectories have not been investigated in this thesis. Secondly, as noted above, selection into education was connected to socioeconomic status, which also likely manifested itself in the physical growth of children. Thus education can also be a mediator between the anthropometric variables and adult cognition. According to recent research presented in 2.5, it does seem that at least height and cognitive abilities share critical periods with each other, possibly through same environmental exposures or not. With a sound identification strategy, van den Berg et al. conclude:

Ultimately, the critical age of 9 for height as well as the critical ages of 8/9 for cognitive ability may then capture the importance of living conditions just before the onset of puberty and its accompanying physiological changes. This suggests that the association between height and cognition observed in the literature may be partly generated through conditions at common critical periods.<sup>383</sup>

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<sup>380</sup> Suomen tilastollinen vuosikirja 1943, p. 53, table 28: Koulunuorison keskipituus ja -paino. Based on Tunkelo 1936.

<sup>381</sup> Peltola 2008, 85–90.

<sup>382</sup> Silva et al. 2006.

<sup>383</sup> Van den Berg et al. 2014.

While the critical periods seem to overlap, the study of Van den Berg et al. cannot disentangle from each other education and other developmental effects, such as nutritional status. While the increase in height could be mostly attributed to improved nutritional status and the direct effect of cognitive stimulation to height should be minimal, the reverse could be true for cognitive abilities. Thus it is impossible to say whether the critical periods just coincide or share some of the same underlying causal mechanisms and to what extent. It should also be noted, that the difficulty of mastering a new language after the age of nine is increased, as Van den Berg et al. note. Thus it is difficult to translate the results to a context where no change in language happens at this age. All in all, their results do give convincing evidence of a change in the developmental environment affecting anthropometrics, cognition and education. Since the effect is seen at all ages, the developmental environment can be given a causal interpretation on all three outcomes.

Thus nutritional status and education are probably best seen as complements: a well-nourished and healthy child is able to concentrate on learning and developing his cognitive abilities, whether in school or play. The randomized control trials investigating the effects of intestinal parasite eradication give support to this conclusion. The eradication of parasites is mostly analogous to an improvement in nutritional status, but at the same time leads to an increase in schooling and school test results. As Horrell et al. argue, a nutritional poverty trap means that a temporary misfortune may push an individual below a threshold of physical well-being that causes persistent impairment to their human capital. When negative health shocks are accompanied by a loss of education or general training, the effects can also be amplified and transmitted to the subsequent generation.<sup>384</sup> This can also manifest itself as a strong inter-generational correlation in cognitive abilities, without the heritability being purely genetic.

A limitation of many studies based on conscript records is that the measures are only available for men. Thus it is not known if the results would differ for women. According to the review by Deary, there is no convincing evidence on gender differences in average cognition.<sup>385</sup> Men have, however, higher variance in educational test scores than women and are thus likely to be overrepresented in both the lower and higher end of the cognitive distribution.<sup>386</sup> What causes these differences is not known. In any case, the developmental environment of Helsinki in the 1930s and 1940s

<sup>384</sup> Horrell et al. 2001, 340–341.

<sup>385</sup> Deary 2012.

<sup>386</sup> Machin & Pekkarinen 2008.

may well have treated boys and girls differently, especially compared to the situation today. Since the Helsinki Birth Cohort also includes girls, some other outcomes than cognitive ability can be examined for them. It is, however, a topic beyond this thesis.

## *7.2 The developmental environment and human capital*

The evidence that growth failure has a huge cost is overwhelming: compared with people who grow well, there is increased susceptibility to infections and greater mortality and losses in human capital in survivors. A population of stunted people will indeed have lower nutritional requirements than will a population with unrestricted growth, which might be seen as an adaptation; however, such a population will be less likely to be competitive in the modern world because of reduced human capital.<sup>387</sup>

The matched brothers data reveal that even after controlling for observed and unobserved family characteristics, differences in height between brothers predict differences in educational attainment implying that differences in childhood health across brothers had long-term consequences in terms of human capital formation.<sup>388</sup>

The developmental environment has changed drastically in Finland since the 1930s. For example, the average height of Finnish men is now 181 cm, while in this sample it is 176 cm.<sup>389</sup> Conscripts of the 1930s were only 171.4 cm tall on average.<sup>390</sup> Thus a unique aspect of this study is that it is set in the context of a currently highly developed country that was still relatively poor when the study cohorts were born.<sup>391</sup> 1930s was also an era before the age of the welfare state, social security or universal public health care. While the connections of early-life socioeconomic status and the development of cognitive abilities might be context-specific to some extent, their biological basis implies that some of the underlying mechanisms are similar in different contexts. In 2007 it was estimated that over 200 million children under the age of 5 are not fulfilling their developmental potential in the developing countries.<sup>392</sup> Besides, currently developed countries are not safe from the effects of early-life socioeconomic impacts on child development. The financial crisis and austerity policies have resulted in alarming reports from Greece, for example, where the long-term falling trend in infant mortality has reversed. Infant mortality rose by 43 per cent from 2008 to 2010: “Neonatal deaths suggest barriers in access to timely and effective care in pregnancy and early life, whereas post-neonatal deaths point to worsening of socioeconomic circumstances.”<sup>393</sup>

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<sup>387</sup> Victora et al. 2008.

<sup>388</sup> Parman 2015, 61.

<sup>389</sup> Saari et al. 2014.

<sup>390</sup> Alho 1940, 436.

<sup>391</sup> Hjerpe 2008.

<sup>392</sup> Grantham-McGregor et al. 2007.

<sup>393</sup> Kentikelenis et al. 2014.

It remains to be seen how the transition in the early-life developmental environment has contributed to the high levels of human capital in Finland today, as exemplified by high rankings in several world indexes, such as the Global Competitiveness index (4.), Programme for International Student Assessment (5.–12.) and the Human Development Index (24., inequality-adjusted 11.).<sup>394</sup> This is especially important in the light of the fact that Finnish economic growth has depended to a large extent on increases in labor productivity and human capital since the Second World War, but in the 1960s levels of education were still some of the lowest in Western Europe.<sup>395</sup> The cohorts analyzed in this thesis were part of this transformation, going to school and entering the labor force in the 1950s, and reaching retirement age at the turn of the century. In their childhood, they experienced one of the first nascent features of a Nordic welfare state – the child welfare clinics that have carried information about their childhood growth until today. The developmental environment of their grandchildren, in turn, included all the other social services of a modern Nordic welfare state: child and maternity benefits, free education and universal healthcare. For these children, socioeconomic status may still be an important determinant of cognitive ability, but the association is likely to be weaker than before.

### *7.3 Conclusion*

This thesis has examined the relationship of early-life socioeconomic status on cognitive abilities in adulthood in a cohort of men born in Helsinki in the 1930s. With linear regression, it has shown that childhood SES predicts performance in a military cognitive abilities test in early adulthood with and without other covariates. Many of these other covariates are likely to be mediators of SES, and thus both over-control bias and collider bias complicate the estimation of the total effect of socioeconomic status on cognitive abilities. Some clues about the possible mediating role of other factors were sought by presenting the results first without the mediators and looking at how the coefficients change when the mediators are added.

Education was a strong predictor of cognitive performance and could be a mediator of socioeconomic status, since the effect of both parental income and father's occupational status was lower when the education dummy was added. In addition, anthropometric measurements serving as proxies for nutritional status were also related to both cognitive abilities and socioeconomic status. Thus they may also mediate the effect of

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<sup>394</sup> World Economic Forum 2014; OECD 2012; United Nations Development Programme 2014.

<sup>395</sup> Kokkinen 2012; Hjerpe 2008; Tuomaala 2011, 110.



socioeconomic status on cognitive abilities. While causality cannot be established, the results highlight the importance of examining the interconnections of socioeconomic status, nutritional status, education and cognition in a longitudinal life-course framework. These interconnections imply strong complementarities between investments in each and thus have far-reaching implications for human capital, social policy and economic growth.

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## APPENDIX 1: RECORDING THE TAX DATA, IDENTIFICATION OF CASES AND DATA CLEANING

The municipal tax records are organized in alphabetical order by first the surnames and then the first names. The parents of the children were systematically searched from the records, starting from the last names recorded in birth, child welfare clinic and school records. Father's last name was used as the reference point and if the father was not found or the mother was not recorded together with the father, she was searched separately with both the father's last name and, if not indicated as having the father's last name in some of the records, with her maiden name. The names recorded in the birth, child welfare clinic and school records are often not precise. Especially nicknames abound and the order of first and middle names may be reversed.<sup>396</sup> For common surnames, it was sometimes impossible to go through all names, but several different varieties and combinations of names were used. The certainty of each identification was marked with a separate variable<sup>397</sup> and later the information for each case for all the years was compared to identify mistakes that were corrected.

Since all years were recorded in the archives by different research assistants, the mistakes in identification should not be systematic across years, except for some very unusual cases, if individuals with very similar names, birth years and occupations existed in real life. Even some of these cases were identified when more years of data became available, since the data contains more information for the latter years. The cases that could not be identified with certainty were also verified from the address register of the police.<sup>398</sup> There is, however, still a possibility that some cases are not correctly identified. Some of them might become apparent later, when the tax record data for the 1940s becomes available, but some may remain miss-specified. Due to the amount of information for identification in the birth, child welfare clinic and school records as well as the tax records, these cases should be only rare exceptions, mostly cases where information is only available for one tax year and comparison of data from two or more years is not possible. Some cases also have very limited information in the

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<sup>396</sup> For example, the name could be Kalle instead of Kaarlo, Mikko instead of Mikael or Karl Johan instead of simply Johan.

<sup>397</sup> K as in *kyllä* for yes certain, E as in *ei* for those not found and T as in *tarkista* for those to be verified. Thus those marked with a t could be later checked against info from the other years.

<sup>398</sup> Helsinki Police Department: Address register 1907–1948.

birth and child welfare clinic records and if the school card is missing, these individuals may have a higher rate of error. Any cases with uncertainty about identification after checking all the available information have been excluded.

The tax units are reported in three columns: the first column is for income from land or property, the second column for income from a business, trade or profession and the third column for income from wages, interest or other sources. Most individuals in the sample have income in the third column. No fathers have tax units in the first column and 17 fathers have tax units in the second column. For the mothers, one has tax units in the first column and 9 have tax units in the second column. In addition, the total sum of taxes paid and the tax installments are recorded, as are the previous year's tax units that should agree with each other over the years. Thus it has been possible to systematically compare the tax unit and the total amount of taxes paid as well as the tax unit of one year and record for the subsequent year documenting the previous year tax unit to identify data entry mistakes by the research assistants. There were some mistakes for each year, but a clear reason for each could be identified, except for one case, where the total amount of taxes paid did not correspond to the tax unit or to the tax installments paid and no clear typo could be detected. Since the tax installments agreed with the tax unit, the tax unit was not changed for this case. For the clear cases, the most common reasons for mistakes were the changing of places of two or more digits, the misreading of a digit and entering the mother's tax units in the father's columns when the father was not found.

In addition, tax units were sometimes changed after complaint to the tax inspection board<sup>399</sup> and this has been marked in green on the sheets with a red stamp of the tax inspection board. The green tax unit has been used as the actual tax unit in this thesis in cases with complaints. This is because the reasons for the complaints are not recorded and thus it is impossible to estimate, which tax unit more closely represents the actual income of the family. However, a successful complaint is likely to more accurately reflect the actual financial situation of the family, since the tax system was designed to compensate for difficult situations in the families through discretionary deductions. Often the tax unit was not changed at all after complaint, but sometimes it was slightly reduced and sometimes all the way to zero, especially in cases of death. In rare cases the tax unit could also be increased. In the sample the tax unit was reduced after complaint for four fathers and not changed for two fathers. For the mothers,

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<sup>399</sup> *Tutkijalautakunta* in Finnish.



there is one case whose tax unit was changed and two cases whose tax unit was not changed after complaint.

## APPENDIX 2: FINNISH–ENGLISH TAX VOCABULARY FOR THE 1930S

*henkikirja* = state population register, “life table”, “life book”

*kunnanveroluettelo* = municipal tax records, municipal tax roll, municipal tax book

*köyhäinavustus, köyhäinapu, köyhäinhoito* = poor relief

*Köyhäinhoitolautakunta* = Poor relief board

*huoltoavustus, huoltoapu* = Maintenance relief or public welfare, analogous to poor relief from 1937 onwards

*Huoltolautakunta* = Maintenance board or Public welfare board, name of the poor relief board from 1937 onwards

*lapsivähennys* = child deduction, a tax deduction based on the number of children under 15 years of age in the household

*perusvähennys* = basic deduction, a tax deduction given based on the amount of income

*Tutkijalautakunta* = Tax inspection board, a board that handled tax complaints

*veronalainen tulo* = taxable income. During the 1930s *veronalainen tulo* meant the income used for taxation after tax deductions. Dividing it by 100 gave the *veroäyri*.

*verotettava tulo* = income liable to taxation. During the 1930s *verotettava tulo* meant the income to be declared for taxation, before tax deductions were applied.

*veroäyri* = taxation unit. *Veronalainen tulo* divided by 100.

*veroäyri valituksen jälkeen, niin sanottu “vihreä äyri”* = taxation unit after complaint, so called “green taxation unit”, because the new taxation unit after complaint was marked in green in the tax records.

*veroäyrin hinta* = price of the taxation unit. The amount of taxes to be paid by each person was the number of taxation units multiplied by the price of the unit, which was set by the municipality.

*veroerä* = tax installment. Taxes were paid in installments. Usually one, two or three installments together with the total amount of taxes paid are marked in the tax records.

APPENDIX 3: EXAMPLES OF TAX RECORDS FOR 1936 & 1939

The Helsinki City Archives kindly gave the permission to publish these photos.

Tax units (third column)		Birth year and occupation		Record number	
478	Surname, Names	77	faktori	747-956-	3585-
478	v alistaajater	86	Wife's names	126-	168-
84	Street	33	711	630-	
928	Address		Area code		

Tax units (three columns)		Pension records		Tax installments	
104	Surname, First names	57	Occupation	208-	260-
128	nm Birth date	296	Kuolema järvi, Liikeapulainen	884-	
	v. Name Maiden name	511	Number of children		
	nm Birth date	511	Liperi		
	Address	15	41	24-	30-
			426	102-	
			67		

## APPENDIX 4: CONVERSION OF TAXABLE INCOME TO REAL TERMS

The tax units were converted to real terms in order for the units of different years to be comparable. Table A1 reproduces the cost-of-living index constructed by Hannikainen and the official index from the Ministry of Social Affairs.<sup>400</sup> The base year as well as the reference year is 1928 for both.<sup>401</sup>

**Table A1. Cost-of-living indexes for Helsinki**

Year	Hannikainen	Official
1928	100	100
1929	98.9	98.7
1930	89.8	89.3
1931	81.1	80.9
1932	81.4	80.8
1933	79.2	79.9
1934	77.5	78.9
1935	79.9	80.3
1936	80.0	80.1
1937	84.5	84.7
1938	86.7	86.5
1939	89.2	89.1
<b>Source:</b> Hannikainen, Matti. 2004. Rakentajat suhdanteissa. Palkat, työttömyys ja työmarkkinakäytännöt Helsingin rakennustoiminnassa 1930-luvun laman aikana, p. 201.		

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<sup>400</sup> Both according to Hannikainen 2004, 120–126 & 201, appendix table 13: Elinkustannusindeksejä Helsingissä vuosina 1920–1939.

<sup>401</sup> Feinstein & Thomas 2002, 507–525.